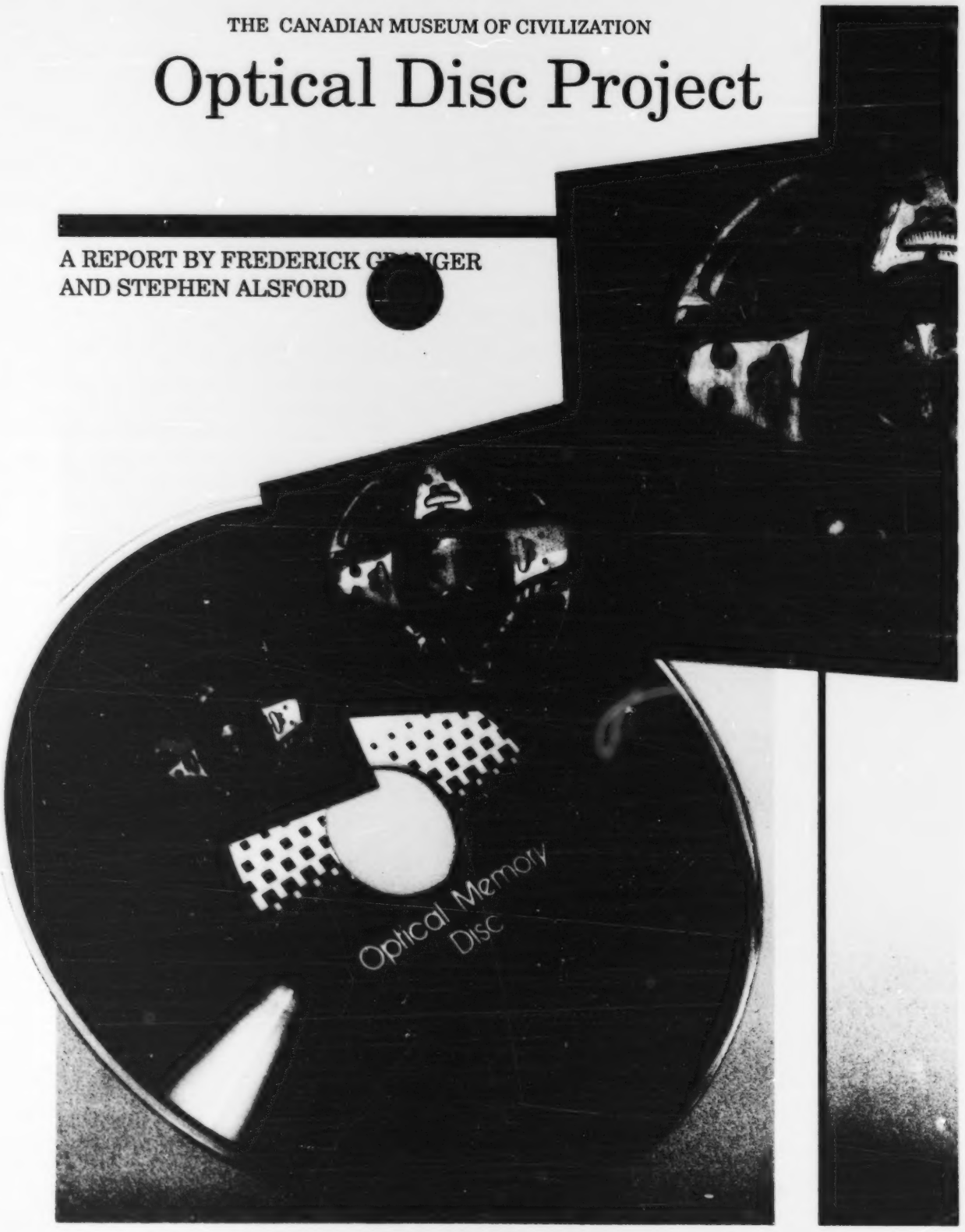
THE CANADIAN MUSEUM OF CIVILIZATION

Optical Disc Project

A REPORT BY FREDERICK GRANGER
AND STEPHEN ALSFORD



88-03310/

CANADIAN MUSEUM OF CIVILIZATION

Optical Disc Project

A REPORT BY FREDERICK GRANGER AND STEPHEN ALSFORD

©National Museums of Canada 1988

Canadian Cataloguing in Publication Data

Granger, Frederick.
The Canadian Museum of Civilization Optical Disc Project: a report

Includes bibliographical footnotes.
Bibliography: p.
ISBN 0-660-10779-1

1. Optical disks. 2. Optical Disc Project (Canadian Museum of Civilization). 3. Optical storage devices. 4. Canadian Museum of Civilization. I. Alsford, Stephen, 1952- . II. Canadian Museum of Civilization. III. Title.

TK7895 M3 G72 1988 621.36 C88-0991003

Cover Graphic Design: Yves Paquin
Photos: Harry Foster and Richard Garner
Photos on page 26 and 44: Richard Garner
DESKTOP PUBLISHING layout and design:
Arlen Bartsch

Published by the
Canadian Museum of Civilization
National Museums of Canada
Ottawa, Canada
K1A 0M8

Cette publication est aussi disponible en français.

CONTENTS

Introduction 1

1.0 Optical storage technology 4

1.1 A note on terminology 4

1.2 An overview of the technology 5

1.3 General benefits of laser disc technology 7

1.4 Obstacles to the spread of laser disc technology 8

2.0 Optical information systems applications 11

2.1 Applications in libraries 11

2.2 Applications in archives and records management offices 12

2.3 Applications in museums 13

2.4 Applications in other institutions 16

3.0 Foundations of the Optical Disc Project 17

3.1 Information resources management in the CMC 17

3.2 The New Accommodation project 19

3.3 Applications envisaged for optical information systems in the CMC 21

3.3.1 Collections management 21

3.3.2 Research support 22

3.3.3 Exhibit design support 22

3.3.4 Public programming 23

3.3.5 Dissemination of information 25

3.3.6 The Médiathèque 25

3.3.7 Promotional applications 26

4.0 The pilot project 27

4.1 The Project Initiation Proposal 27

4.1.1 Objectives 27

4.1.2 Project participants 28

4.1.3 Project components 28

4.1.4 Resources and facilities 29

4.2 The videodisc sub-project 30

4.3 The optical disc sub-project 31

4.3.1 Digital DRAW 31

4.3.2 Analogue DRAW 32

4.4 The exhibit design support sub-project 33

4.5 The audio collection sub-project 33

4.6 The interactive element 34

4.7 Findings of the study 36

5.0 The operational phase 39

5.1 Recording the collections 39

5.1.1 The CCFCS project 39

5.1.2 Progress of the project 40

5.1.3 Future plans 41

5.2 The textual database and database management programme 41

5.3 Overall system setup and search process 42

6.0 Image automation and museums 45

Footnotes 49

Select bibliography 52

Appendices 54-58

Introduction

Laser-technology-based optical information systems are looked upon as one of the "new technologies" that are beginning to have a significant impact on both our professional and personal lives; with wide-reaching applications in government, business, industry, the information sector, and home use, it promises to prove a pervasive technology. In some respects, however, the technology does not seem so "new": although only on the market for a decade now, it has undergone many changes in that period, with more foreseen in the future. Fierce competition to develop state-of-the-art systems has led to the demise of some branches of the technology, and those manufacturers which survive in this environment show more concern, it is often charged, with future developments in the marketplace than with the needs of present consumers - among which is the need for market stability. This rapid pace of technological development can therefore be an inhibiting factor in the adoption of optical storage media, contributing as it does to confusion and misinformation amongst potential consumers.

There is no shortage of literature - mostly periodical articles, although a few books have appeared in the last couple of years - discussing the capabilities of optical storage technology and pointing to potential applications. But the time-lag between events written about and publication is often sufficient to make at least some of the information therein outdated, particularly in contrast to literature emanating from manufacturers which all too often describes new products not even on the market. Although there has been much general discussion, in print, of optical storage technology and its benefits, there remains a shortage of readily available (i.e. published) information in the form of detailed case studies concerning projects implementing the technology. Of the institutions that belong to the information sector, this lack of reporting seems most true of museums. One encounters increasing attention paid to the issue of optical storage in literature of the publishing, records management, archival, library and information science worlds - sufficient interest to have spawned journals specializing in the subject - yet in museological journals there are relatively few articles on the theme, and even fewer that are individual case studies.[1]

The variety of technological alternatives confronting the potential consumer in the optical storage marketplace, combined with the constant advances which make it difficult for non-experts to keep clear track of what is "in" and what "out", and also the paucity of published information which might be helpful in providing data for the decision-making process, have contributed to encouraging museums to play a watch-and-wait game. Many more institutions consider employing the new optical information systems than actually do employ them; even those institutions which do become actively involved often do not progress beyond the pilot study/demonstration disc stage. There are other factors at work, of course, affecting particularly smaller institutions of limited resources: lack of in-house expertise applicable to the identification of the most appropriate subset of existing technology to meet given institutional needs; technological problems, such as lack of compatibility between different systems; and of course the investment of capital and labour resources necessary for the implementation of an optical storage system which, despite the fact that costs are dropping quite dramatically as the technology matures and the marketplace (gradually) expands, can still seem prohibitive-

ly high to an institution with small or inflexible budget.

It is understandable, yet unfortunate, that most museums stand aloof, whether by choice or necessity, from technological developments that have so much promise. A promise that lies in long-term reduction of costs that will more than pay back the initial expense of implementing the technology, in automating functions presently performed manually so that existing staff are enabled to be more productive or to be redeployed to tasks previously neglected, in improving the effectiveness of museum operations on several fronts, and in the ability to enhance museum services. What optical storage technology offers is the opportunity for museums to manage their information resources - artifacts and mentafacts - better, and to provide their clients with a higher quality of service based on those resources. Museums have, until now, faced a major dilemma imposed by the conflicting goals of preserving their collections and providing access to those collections. Optical storage media present the means to a resolution - if not a perfect one, then certainly a workable compromise - of this problem: to increase access to collections information while reducing the risk to collections inherent in the concept of access.

Museums, perhaps more than libraries, archives, or similar institutions (which are predominantly - though by no means exclusively - concerned with textual media, whether printed or machine-readable), should be natural exploiters of this new technology, for museums are to a greater extent multi-media institutions, and the laser-based optical information media have the greatest potential of any technology yet developed for mixed-media storage and presentation, with all that implies for the integration of information normally held in separate collections. Above all, museums emphasize visual information, at a time when research trends show more appreciation of the value of artifactual and pictorial materials, and there is an increase in multi-disciplinary interests to which traditional information classification systems are finding it difficult to respond satisfactorily. Both the general growth in the volume of information, in a variety of forms, which museums must manage in an effective fashion, and the growth in the number of requests for access to that information, necessitate that museums seriously consider new systems for storage, retrieval, and delivery of information. What they require primarily is image automation, something made possible by the optical information technology, particularly when combined with the organizing and retrieval power and flexibility of computers, to which museums are no longer the strangers they once were.

It is, arguably, the larger institutions with greater resources at their disposal which must lead the way into exploitation of new technologies. Certainly the Canadian Museum of Civilization recognizes its responsibility to provide, by example, and by pioneering efforts, guidance and assistance to other Canadian museums with regard to the development of techniques and services which may allow them to perform their functions and attain their objectives more effectively and successfully. In the context of the federal government's committment to building new facilities for the Canadian Museum of Civilization, the opportunity was provided for a major re-thinking of all the museum's operations and programmes, and plans were made to upgrade them wherever there was felt to be room for improvement. Optical storage technology was one of the vehicles for such improvement considered very early on in the New Accommodation project, and a firm committment to this technology was made in 1983 - making the Canadian Museum of Civilization (or as it was then, and until the summer of 1986, the National Museum of Man)

the first Canadian museum to so commit itself. It was not until 1985 that extensive research was concluded and a hands-on pilot project undertaken to produce demonstration discs; the purpose of the pilot project was to evaluate alternative technologies and techniques and the relative quality of their products, and to identify the medium, equipment structure, and approach to information resource management that were most suitable for envisaged museum needs and applications. Those needs and applications range widely across the spectrum of museum activities: collections management, research, exhibition support, public programmes, dissemination of information. But the central issue addressed was that of providing more adequate and better integrated access to the collections and collections-related information resources, which have previously been fragmented (by discipline-based museum Divisions, and by media-type) and of restricted accessibility.

The purpose of this report, then, is to offer a contribution that will, hopefully, be of some assistance to the museum community in assessing the new optical information technology and its potential uses. This it does in the full knowledge that the information contained herein, reporting events some of which lie almost two years in the past, and a state of technology more applicable to 1985 than the present year, cannot be of maximum utility. The focus of the report is on the pilot study which took place between September and December 1985. The Canadian Museum of Civilization's Optical Disc Project has since passed to an operational phase, and the progress of that is also reported here; it will be several years before the production of discs bearing collections information is complete, although it is expected that the early discs will be available for use at the time of the opening of the new museum, in 1989. It has also been found desirable to preface the discussion of the Canadian Museum of Civilization's project with a general introduction to optical storage technology, and with brief examination of selected similar projects undertaken by other institutions. The overall purpose of all sections of this report, however, is to try to show the various applications and benefits of optical storage systems, and it is believed that the points which may be made in that regard are not so quickly outdated.

1.0 Optical Storage Technology

1.1 A note on terminology

It is an unfortunate fact that the rapid rate of development of optical storage technology, the multiplicity of products on the market, and the diverse backgrounds (and consequently predilections) of users and reviewers of those products do not create a stable environment in which a standardized terminology might take form. This circumstance promotes the consumer confusion which acts as an obstacle to the technology catching on. At this point there is no sign that differences of opinion as to spelling, definition, or usage are resolving themselves.

One difficulty lies in the spelling of the information medium: disc or disk? Either is technically correct. The reason that both are used stems partly from the fact that optical storage technology owes something to several different fields of technical reference: the music recording industry, in which *disc* is the standard; the audio-visual community, likewise preferring a *c* termination; computer users, however, are at home with the spelling *disk*. Manufacturers tend to use *disc* more often than *disk*, although their rationale for selecting one or the other in any particular case is based more upon marketing ploy than logic. Professional literature, as well as some general, but authoritative, sources such as the Wall Street Journal, New York Times, and Encyclopedia Britannica, have opted more in favour of *disk*. Videodisc is increasingly uncommonly found spelled with a *k*, however, and usually as a single word now. In this report *c* will be used in all contexts where laser discs are mentioned, for purposes of internal consistency and to distinguish from *disk* when used to refer to magnetic storage media used in computers.

A more serious problem is different application of terms, notably *videodisc* and *optical disc*. The former is often used as referring to the medium storing analogue signals, the latter as a digital medium. As a generalization this has some validity, but matters are not really so simple: although videodiscs are primarily used to store graphic images of one sort or other, and these images are normally transmitted as analogue signals (that is, a signal capable of producing an image on a standard television screen), it is possible to convert them to digital form for storage; similarly, the possibility of converting digital to analogue further blurs the distinction. Again part of the difficulty stems from the different backgrounds of users of the technology: the audio-visual community is accustomed to thinking in analogue terms, the computer community in digital terms. Rather than plunge into a technical discussion of the various types of optical media, it is felt necessary here only to define the way in which the two terms will be used in this report:

- videodisc - discs that are produced by recording the original data (directly or indirectly) on videotape as a prelude to transferral to master-disc, in a plant with special equipment for that purpose.

- optical disc - discs that are directly recorded from a computer or a camera input.

This usage may not correspond precisely to all definitions given by other sources, but will be functionally useful for purposes of this report.

A third problem is in finding a generic term to cover the range of technologies used in the 'hi tech' optical information systems. *Optical disc* has sometimes been used as a generic term, but not strictly correctly; certainly it does not suit the terminological structure desired for this report. *Optical storage technology* has already been used as a generic in this report. However, one may argue that this term misleadingly reflects only one aspect of the technology's function: that it is not only for the storage of data, but also for information delivery and dissemination. Laser disc has occasionally in the past - and will here be - used as a generic in that lasers have been the principal devices for recording and reading disc data; this is not always the case in fact, but alternative systems are now outdated and rarely found in North America.

1.2 An overview of the technology

It is not proposed in this section to discuss technical aspects in any detail, but to review, briefly, certain features of the technology and to distinguish between a few of the different types of media, in order to help illustrate the general benefits and applications of the technology. Many of the articles in the select bibliography at the end of this report will provide further technical details, if the reader desires such. Although the information herein merely summarizes and simplifies that found elsewhere, it is impossible to avoid entirely some general discussion of the technology, if the reader is not to become confused by later sections of the report.

All optical media use variations in light to represent informational content. This light is either reflected off or, less commonly, transmitted through the information storage medium - the disc - which basically comprises a thin layer of information-bearing material which is encapsulated in a protective layer of plastic or glass.[2] The basis for the technology is the laser, used to record information on disc by burning marks (in some systems holes or "pits" are burned, in others blisters are made to form) onto the sub-surface strata; less commonly the laser may be used to burn through the recording surface. As the laser is focused on the substrate, the protective layers around it are not affected during this process. The markings are made in tracks which may be either one continuous spiral or a series of concentric rings, depending on the system. In the playback system, a lower-powered laser, generating no heat, is used to detect the variations in the markings on the substrate, these variations being converted into signals intelligible to human senses.

Quite a few variations in optical media are possible, according to whether the technology is digital or analogue, optical (i.e. laser-based) or capacitance (no longer produced in North America), pressed by commercial operations or recorded directly by the user; different systems also utilize different-sized discs. In digital systems the string of evenly-spaced laser markings and spaces between markings are read as a series of binary digits - that is, ones and zeros; this digital signal may be sent, as such, to a computer to be read, or converted to an analogue signal for display on a television screen. The continuously variable frequency-modulated signal that is the basis of analogue systems is encoded on disc as variances in the lengths of marks and the spaces between marks. Analogue systems, which were the first type marketed (1977), do not require the use of external computers to make the signals readable on monitors. They are naturally suitable for recording audio or video; the analogue signals from such sources can be digitized and stored in that form, but it requires quite a bit of space (perhaps 200-250 kb) to store one image, and digital discs are therefore really only efficient for image storage if compression techniques are used on the data.

The earliest laser disc systems to be commercialized were "read-only", and these remain in the majority today. Read-only discs are mastered, and replicated, under clean-room conditions, using high-speed, precision equipment which is too expensive for users to own and operate themselves. Videodiscs - the motherlode technology - are read-only and normally analogue.[3] In 12" size, these were marketed in the late "70"s as entertainment products, as well as for educational and archival projects. Read-only videodiscs - also known as universal discs, because one make of player can generally play discs produced for other makes of player - come in two formats:

- CLV (Constant Linear Velocity) is used primarily by the entertainment industry, to hold motion video. The contents are viewed sequentially, along a spiral track, only very limited access to different sections being possible, and there being no freeze-frame capability.

- CAV (Constant Angular Velocity) is for still images primarily; motion pictures may be put on CAV, but not very space-efficiently. The capacity of CAV is only half that of CLV, as tracks are concentric rings, but CAV permits random access to each individual frame (equivalent to a track), unlimited freeze-frame, stepping of frames one by one, slow and fast motion, and even faster scanning speed, all without loss of picture quality.

Whereas read-only discs are recorded for users by commercial facilities, write-once systems provide users with the means to carry out the recording in- house. Often referred to as DRAW (Direct Read After Write) or WORM (Write- Once Read-Many), this type of system allows the user to record directly from some other device - such as a video camera, videocassette recorder, or computer - and to check each recorded segment immediately afterwards for accuracy; should any errors have occurred, that segment can be re-recorded on the next part of the disc. This dynamic error-identification and correction capability is one of the principal advantages of write-once systems; errors that occur during the mastering/replication of read-only discs cannot be corrected (without producing an entirely new master) although such errors, perceptible as drop-outs, are rarely obtrusive to the senses. Once information has been burned onto a write-once disc it cannot be erased or re-written over; reading is the only option following initial writing. On the other hand, the user does not have to record the whole disc at once; additional data can be added at a later time on any areas of the disc left unwritten. Erasable and re-writable disc systems are presently under development, but are not likely to be available commercially for some years - although Kodak recently introduced a thermomagnetic-optic erasable system.[4]

12" discs were the first size to be marketed, and this remains a very common size; a CAV videodisc of this size can hold 54,000 still images per side, which at a speed of 30 frames per second allows for 30 minutes of motion video, with a corresponding capacity for audio.5 A 12" optical digital disc could hold 655,000 A4 sheets of text, or 3,200 microfilms (AG), or 40,000 graphic images, or 1800 hours of audio (LPC 2400 bit/sec), although capacity varies from manufacturer to manufacturer. Compact discs, being of smaller size, are more portable and easier to distribute, but hold less; audio compact discs are 4.72" and CD-ROM 5.25", to make the latter compatible with other types of computer disk. 8" discs are also considered a more easily transportable size, fitting well into a briefcase for example, and are becoming increasingly common in North America for video

applications. There are also 14" discs on the market, their advantage being higher storage capacity. Kodak/Du Pont's recent 14" product has 6.8 gigabytes; at the same time Kodak displayed a 3.5" disc. There is no sign yet that any one size is likely to become predominant in the near future.

It is not sufficient for discs to store information, of course; there must also be a means of accessing, or retrieving, that information. Various options are possible:

- The contents of a disc may be viewed in a linear, sequential fashion, using basic disc player controls (start, stop, fast forward, rewind).

- Individual images may be selected by entering their frame numbers on the player's numerical keypad. This assumes some index of the images, referring to frame numbers, is available, say in printed form or recorded on the disc itself.

- Some players (industrial, rather than consumer, models) have built-in microprocessors which permit access to particular desired sections by using a disc-embedded programme, providing one or more menus from which the user may make a selection.

- By interfacing the player with a computer, the latter may be used to control access and drive the player; the index to contents may itself be computerized, and data may be stored both on disc and in the computer, with simultaneous access to each. This is generally the most effective way of managing a large disc-based collection of information, allowing for much greater flexibility in stating retrieval parameters. Input into this system can be made by a variety of means - keyboard, light pens, graphic tablets, joysticks, mouse-like devices, touch screen, voice input - so that computer expertise is not necessary to effect retrieval.

The first two of the above options are often described under the title of Level One systems, the third option as a Level Two system, and the final option as Level Three.

1.3 General benefits of laser disc technology

The various benefits provided by disc-based optical information systems are well-documented in the literature; but it is worthwhile to repeat them here. One of the most commonly cited advantages of laser discs is their storage capacity compared to their compact format. This capacity varies according to the type and size of disc - a couple of examples have already been given [section 1.2] - but in all cases it means that the discs must be rated highly as an archival medium, offering substantial savings in storage space. Accordingly, users are given access to databases larger than would be available to them on computer-based magnetic disk, and much larger of course than on a comparable (single) unit of traditional, microform, optical media. Only for motion film can videocassette outdo its analogue equivalent in disc. Even more massive databases can be made accessible to a user by stacking disc-players in a single coordinated unit, or by grouping discs in a jukebox. The high storage versus small size of discs has made them an excellent vehicle for distribution of information (e.g. by mail).

Perhaps even more important than their space-efficiency, is the fact that laser discs are multi-media storage/retrieval devices. It is not

merely that a wide variety of systems have been developed to accommodate different types of media - although there do tend to be specializations (analogue for video, compact disc for music, CD-ROM for text) - but that in many cases different types of original media can be put together, in any mixture, on the same disc. It is not difficult to envisage the advantages of having simultaneously accessible information on any given subject in several forms, where traditional information systems inconveniently separate subject matter into collections of like-format. This advantage must appear particularly strong for multi-media institutions such as museums. The ability to interface disc players with computers increases their value as powerful and sophisticated information retrieval devices: both searchability and processability of data is enhanced. Similarly transmission of data, and thereby sharing of information, is permitted by the player-computer interface; data can be distributed in Local Area Networks or further afield via telecommunications channels.

The durability of laser disc is another of its principal attractions. Environmental requirements for disc operations are not demanding. Temperature and humidity fluctuations (within reasonable limits) have no effect on the disc, although players should be stored and operated at normal room temperatures and if the system includes a computer this should be protected from dust. Dust, dirt, or smoke particles, however, have not effect on the discs themselves; since the information-bearing layer is protected by a transparent coating and since the laser focuses directly on the substrate, surface dust has no effect on legibility. The same is true of surface scratches; the fact is, discs are very robust in the face of regular handling, or mishandling. As the player's laser generates no heat there is none of the colour loss or heat damage to which photographic slides are susceptible when projected; a frame can be frozen and read for an indefinite period without harm to the disc. No contact is made between disc and reading apparatus, which means there is none of the wear that audio discs experience. Nor are laser discs subject to the hazards of their magnetic counterparts in computers, such as hard disk crashes; in other words, laser disc data is comparatively secure from loss.

Although it is premature to describe laser discs as a "permanent" medium, their lifetime promises to be longer than that of most media, without special storage environments required to maintain their condition. A lifetime of ten years is guaranteed by most manufacturers - this being about the limit of our experience with the discs yet - and accelerated aging tests in the laboratory indicate a probable lifetime of several times this. The hardware too has a reputation of being fairly maintenance-free, relative to hardware for other media, and although some problems have been reported,[6] the competitive field is producing better and better equipment. Because of its durability, and its multi-media capacity, laser disc is increasingly being regarded as an excellent device for preserving copies of fragile or deteriorating originals. Microfilm also has a long lifetime, but is not as versatile in the types of information it can store, is more susceptible to mishandling, and does not offer the same sophisticated retrieval and fast access capabilities of a computer-interfaced laser disc system. Discs also offer very high quality reproduction of both video and audio, although access to this quality is presently limited by the quality of the hardware used in reproduction. This quality is particularly valuable in freeze-frame or slow-motion contexts, allowing careful study of stills or motion sequences.

1.4 Obstacles to the spread of laser disc technology

Many potential consumers are discouraged by the expense of hardware and the cost of producing discs. Although hardware prices are coming down, year by year, as the technology matures and the market for it grows, playback equipment is still more expensive than that for videotapes. Again, comparing discs and tapes, the former have a higher playback cost per hour, and cannot be re-used once recorded on. Although this lack of erasability can be an advantage in some applications, laser disc is not suitable for holding data requiring frequent revision or updating; the only way to edit a disc is to copy the old data to be retained, along with new data, onto a new disc, but even this process need not be very expensive (assuming infrequent updates) with DRAW equipment now on the market.

The pre-mastering and mastering of a videodisc is certainly a fairly expensive process. The key to profitability here is multiple replication: the higher the volume of copies produced, the cheaper the per-unit cost; discs are, essentially, made from comparatively inexpensive materials, and CD-ROM, for example, has been found so cheap for mass reproduction that it is considered a throw-away material. Videodiscs are best thought of as a mass distribution medium. If such distribution is not intended, as is usually the case in, say, archival projects, then the less expensive route will be DRAW technology; that is, in-house disc production. The hardware here is more expensive than that required for videodiscs, but the price of master-disc production can be cheaper, depending on the amount of labour that will be necessary in each individual case. However, when considering the costs of laser disc technology, one must naturally weigh them against benefits such as of savings in storage space, durability of software/hardware, and improvements in operational capabilities.

Compounding the deterrent of costs is the fact that consumers cannot freely shop around for systems, cannot mix-and-match components. So far the industry has failed to develop the standards that would permit compatibility between systems. While videodiscs tend to be playable on most systems, interactive discs (i.e. discs including programming) are usually mastered to work with a single, specific system. In particular there is a lack of standards in the formatting of data on discs and in interfacing computers and disc hardware. The consequence is that the consumer is often obliged to purchase a complete system from a single manufacturer. Progress is slowly being made towards agreement on standards; although this largely relates to CD-ROM, it is anticipated that once standards are improved on that technological subset, manufacturers of other types of laser disc will feel obliged to follow suit in order to remain competitive. A further issue which is often raised relates to the quality of image resolution available from laser disc systems. Although there may be some slight deterioration in the quality of analogue disc data when second, or succeeding, generation copies are made, the real problem lies not with the image storage media but with the image reproduction hardware. This is reliant on NTSC (U.S. National Television System Committee) standards, which are not currently very demanding. Domestic television monitors lack the resolution to display the quality of images actually on disc, and for reproduction of complete pages of text are quite inadequate. High resolution screens are necessary, and as this technology improves a disc will continue to support improvement in the quality of the displayable image. At present even high quality monitors cannot duplicate the resolution of a 35mm slide or filmstrip frame, but it should be remembered that all modes of reproduction of

originals are in some way unsatisfactory (e.g. photographic media may have colour shift problems), and this may be considered especially true of 2-D representations of 3-D objects. Reproduction media are intended primarily to serve purposes of convenience, rather than quality.

Finally, it may be said that manufacturers are, in some respects, their own worst enemies when it comes to developing markets for optical storage technologies. So competitive is the marketplace, and so rapidly is the technology developing, that manufacturers tend to put too much energy into creating and promoting the next "state-of-the-art" product, and not enough in supporting, and educating users about, what is currently on the market. Consumers, who are often non-experts in the hi tech field and who may not be prepared to invest a substantial amount of time and labour in understanding new technologies, have no great love for technological change and are only offput by manufacturers' apparent relish for technological upheavals. The gap between the capabilities of devices one reads about in industry literature and those actually on the market serves only to further confuse the issue.

2.0 OPTICAL INFORMATION SYSTEMS APPLICATIONS

Again the purpose of this section of the report is not to provide a comprehensive survey of uses of optical storage systems,[7] but to look briefly at a selection of applications with a view to the types of function or service supported by laser disc technology and the benefits obtained therefrom.

2.1 Applications in libraries

In the information sector, few types of institutions have become so heavily interested in optical storage technology than the traditional providers of information: libraries. Library and information science journals are one of the best sources of literature on the subject (although this is partly a reflection of the relatively large number of such journals). Libraries are predominantly concerned with textual materials - whether in print or non-print form - and consequently their interest tends to focus on CD-ROM, arguably the best optical medium for mass dissemination of large textual databases. Some libraries, however, have shown interest in laser discs as a device for image, or multi-media, automation.

The U.S. Library of Congress (LC) has one of the largest collections of stored knowledge in the world, and in a variety of formats. In its Optical Disk Pilot Program, which comprised both print and non-print materials components, LC sought to address two principal issues:

- How to improve researchers' abilities to access and use different informational collections, particularly given the modern growth of interest in non-textual sources of information.
- How to preserve information materials, especially those rare, already fragile, or difficult to handle, in the face of increased demand for access.

LC selected laser disc as a promising solution to the problems of access and preservation. Those books in the collection which were undergoing rapid decay through acidification had their text copied onto digital optical disc, via an optical page scanner; discs were made accessible *en masse* in a jukebox player. This system reduced document delivery to a matter of seconds, while before the process might have taken up to an hour. The non-print project involved the transfer to 6 analogue videodiscs of images from several separate collections:motion pictures and TV videotape productions, artists' illustrations, glass lantern slides, negatives and transparencies, individual photographs, photograph albums, architectural drawings, posters; items from the music collection were transferred onto audio compact disc. Again, the interactive programme used to call up items from these discs was able to reduce retrieval time quite drastically, as well as to reduce researchers' handling of the original items which was contributing to their deterioration.

LC has also developed interactive videodiscs to support exhibits in its American Folklife Center. The exhibit *The American Cowboy* was accompanied by a disc holding 2,000 slides of architecture associated with the cowboy, motion picture segments, and interviews. Another disc, used in conjunction with a 1950's cafe setting, allowed patrons to select, from a jukebox, one of twenty traditional cowboy

songs. The durability of videodisc as a display medium (in contrast to film loop, videotape, or slides), the ability to slow or freeze motion sequences, and the ability of users to select the segments they desired to see and to access those segments rapidly, were the attractions of videodisc in this context. LC has also developed an interactive videodisc for training its clients in the use of its automated catalogue.

The National Library of Canada has experimented with videodisc in a similar, but more modest, fashion. Its aims were: to gain experience in videodisc production and in interfacing a computer with disc equipment; to demonstrate the ability to store and present multi-media materials; to demonstrate the validity of videodisc as a research tool. Once more, issues of preserving deteriorating collections and enhancing access to collections lay behind the project. The disc was designed as a stand-alone (Level Two) system, with access programmes embedded; access to segments was via on-disc menus, although the intention was to develop later an interactive (microcomputer-based) programme to retrieve items from one segment. The videodisc contained four productions: a 16mm film about the National Library, for public relations purposes; a 35mm slide show about the publication Canadiana, again a public relations tool; a History of *O Canada*, comprising audio-visual, still image, and music materials; a tour of the library, once more for public relations. Although the conclusions drawn from this experiment were largely positive,[8] it is notable that the National Library has not yet involved itself further in videodisc technology.

Slide librarians have also explored an obvious application of laser discs: archival storage of images. The fading of transparencies, the cost of replacing damaged slides, the labour involved in filing of slides, and the difficulty in reviewing and selecting slides, make laser discs an attractive alternative. At the University of Iowa's art school library a disc was produced containing 1,000 images of woodcuts by particular artists, while textual information from catalogue records was stored on computer, indexed, and interfaced with the disc player. The system was successfully utilized as a research tool for selecting specific individual works.

2.2 Applications in archives and records management offices

Despite the extensive study of laser disc technology undertaken by the federal government in 1981, relatively few Canadian Government departments or agencies have become actively involved with the technology. The Public Archives of Canada was, however, one of the earliest institutions to investigate its potentials, in the late 1970's, by producing a demonstration videodisc storing images of maps, photographs, textual manuscripts, architectural drawings, paintings, medals, and motion picture films; this was intended for research purposes. By the time it made a serious committment to optical storage technology, however, its attention had refocused on the newer digital optical disc, preferring to digitize audio and video records. Its reasons for this choice included:

- It sought a method for archiving data already in digital form; the data was stored on magnetic tapes which required annual cleaning, rewinding, and recopying every 5-8 years, and provision of environmentally stable storage conditions.

- The ability to enlarge portions of the screen image for closer inspection, which required computer control.

- The capability of making high quality black-and-white prints from disc images.

The Public Archives' goal is primarily a system of archival storage that reduces storage space, reduces costs of collections maintenance, and generally improves record preservation.

Another federal body to have implemented an optical storage system is the Royal Canadian Mounted Police. The Identification Services Directorate sought a means of obtaining fast access, high quality reproductions, and a distribution mechanism, regarding its photographic database of Criminal Mug Shots. It opted for an analogue optical disc (DRAW) system, and began to re-record its database in April 1986. It is interesting to note that the system selected by the RCMP is based on the same Panasonic optical disc recorder that the CMC's optical disc pilot project already had recommended for adoption. In fact the Panasonic equipment is now being used by a number of institutions, including: ACCESS Alberta, for interactive instructional programmes; British Columbia Cancer Research Institute, as part of its time-lapse photomicroscopy work; Canadian Film and Video Centre, for slide storage; Department of Energy Mines and Resources, to store images created in aerial survey operations; Emergency Health Services (Ontario Ministry of Health), for providing street maps to ambulances; Toronto Real Estate Board, for storing photographs of properties; and Skyline Cablevision (Ottawa) for providing still-frame images on its advertising channels.

2.3 Applications in museums

In the last few years museums have become increasingly acquainted with computer technology and its applications, but less so with laser disc systems. Nonetheless, many museums have considered the latter and not a few have gone ahead with projects, or have them on the drawing-board, mostly in the United States; it has been estimated that 3% of U.S. museums are using, or planning to use, optical information systems;[9] there is no evidence of much significant involvement with the technology in Canadian museums, however.

Perhaps not surprisingly, it was the Smithsonian which led the way into implementation of laser disc technology in museums. The National Air and Space Museum found two different applications. One was the same type of preservation/access project already described [section 2.1], in this case relating to the museum's collection of original photographic prints, for which copy negatives had not been produced. A demonstration videodisc was produced in 1982 holding 50,000 images of air and space vehicles; the images were accompanied by brief texts and the disc was searchable interactively, by computer. Despite the fact that the quality of the disc was crude - there being no special concern for image quality in this pilot project - consumer demand for copies of the disc surprised the museum. It has gone on to produce further discs in this vein, intended primarily as a device to facilitate staff and public's selection of which original prints they wish to see, and secondarily as a vehicle for disseminating the collections information - hence these discs are designed for stand-alone systems, the consumer consulting a printed index and using player controls to access numbered frames.

Even before the development of these archival discs, the National Air and Space Museum had introduced videodisc imagery into its public galleries. The problem that was necessary to address was that the conventional audio-visual presentation equipment - film loops - used extensively in the exhibition areas experienced rapid deterioration under the pres-

sure of daily use, and needed constant maintenance, repair, or replacement; this was true both of the hardware and the software. In 1981 the presentations were copied onto videodisc, copies of which were used to play the relevant segments on some twenty machines located centrally in a computer facility, with the signals transmitted by coaxial cable to different gallery locations. It was found that far less maintenance work was required with the videodisc system.

Other museums too have used optical information systems for exhibit support. In 1982 the New York Metropolitan Museum of Art installed an "information room" in its new Primitive Art wing. This room held three kiosks, each with a videodisc player: an embedded programme allowed visitors to select, from menus, any of four culture areas of interest to them, and then one of several topics per area. The disc documented these topics with images copied from photographic slides, motion sequences, audio, and text. The Boston Museum of Science has also made heavy use of interactive videodisc to support its exhibits, and found that the work-stations could hold visitors for ten minutes or more. Although this selective survey has largely limited itself to North American institutions, it might be mentioned that Japanese museums, not surprisingly, make fairly extensive use of a technology in which their industry is heavily involved as developer. To take just a single example, the Little World Museum of Man (Inuyama) uses 55 videodisc players to support some 70 audio-visual installations in its galleries; the players are located centrally and controlled by minicomputer. Some presentations involve twin screens, one presenting pictorial information, the other associated textual information. To avoid congestion around a presentation, monitors showing the same information may be distributed throughout an exhibition area.

The Metropolitan Museum is also noted for its successful marketing to the public of videodiscs containing collections information. This financial aspect of laser disc applications, whether a direct goal or a by-product, has not escaped the notice of museums.[10] Philadelphia's Franklin Institute Science Museum produced a disc with railroads as its theme, and offered it for sale along with an instruction manual for interactive programming and a directory to the images on the disc. The Smithsonian's National Gallery of Art has collaborated with publishing houses to produce a disc which provides a 30-minute gallery tour and 1,500 stills, accompanied by basic catalogue information, representative of the museum collections; copies of the disc are both sold in the museum shops and loaned to other museums as part of the education extension service. In a similar vein, the International Museum of Photography at George Eastman House produced a videodisc giving a brief tour of the museum followed by a pitch by staff explaining the benefits of laser disc technology. The purpose here was to use copies of the videodisc as a fund-raising tool, to support a planned archival project: the transfer of images from fragile (and consequently inaccessible) photographic materials to approximately one hundred discs.

Many laser disc projects are aimed primarily at improving access to collections information while at the same time not jeopardizing the original artifacts. The Ornithology Division of Philadelphia's Academy of Natural Sciences sought to develop a comprehensive disc-based library of bird images (copied from slides) to facilitate researchers' efforts while at the same time protecting the original collections from unnecessary handling, and also reducing the amount of time expended by staff in retrieving and refiling original images.[11] One of the earliest pilot projects relating to laser disc technology in museums was undertaken by the

Museum of Fine Arts in Boston, in 1980. 2,000 slides from the museum's slide library, of art objects from the museum collections, were transferred to videodisc. Initially this was a Level Two system, with a printed index (organized by department and subject) and player controls used to retrieve images, although the long-term goal was to make the system interactive. Again the purpose was to create a browsing device to allow library users to select the slides they wished to borrow. There was a slightly different bias to a project of the Horner Museum (State University of Oregon), which had two separate collections divided up between several different storage locations. A disc was created holding images of 3,000 objects from the collections, with related textual information, in order to provide the means for accessing information on physically scattered collections from one central location. Once more similar elements are seen in the project of the Margaret Woodbury Strong Museum: to put on disc, images of a collection of paper ephemera, which are fragile and unable to bear the frequent handling inherent in the manual selecton process. Researchers would be able to scan the images of the collection and select the items of interest to them, which could then be retrieved for firsthand study.

Smaller, more poorly-resourced museums are at a disadvantage when considering the feasibility of utilizing optical information systems to meet their needs. A few museums have found that co-operative projects will help them implement the new technology. The University of Wisconsin's Helen L. Allen Textile Collection was the subject of a videodisc project begun in 1982, to document 12,000 textiles, costumes and related objects. Images and catalogue information were both made available via an interactive system. Again the principal objective was to create a tool to allow researchers to select the items of which they wished to see the originals, thus reducing the number of artifacts which might have to be handled directly in preliminary investigations. This project was only possible because the costs and workload were shared by other units in the university; since that time several other university departments have initiated their own laser disc projects. The museum has recovered some of the project costs by selling copies of the disc.

Although two Toronto businessmen attempted, in 1983, to set up a cooperative project whereby Canadian museums, art galleries, display centres, libraries, and archives might jointly finance the production of a videodisc containing promotional programmes describing the locations, activities, and collections of each of the participating institutions - a public relations tool aimed at enlarging participants' clienteles - Canadian museums have been reticent in involving themselves with the technology. The University of British Columbia Museum of Anthropology is a rare exception. At the same time as its staff were conducting research into laser disc applications in other North American institutions, the museum cooperated in the "Vancouver Videodisc", a project sponsored by the Vancouver Arts, Sciences, and Technology Centre, (VAST). This joint project's disc included segments from the museum and from other local cultural organizations, as well as images of Canadian art, posters, archival photographs, and motion sequences. The disc is used with an interactive system, in the VAST Centre, and employs touch screen technology for information retrieval. Impressed with the results of this project, and with the findings of the survey study, the Museum of Anthropology has experimented with the provision of catalogue information, essays, and short image-based programmes, accessible from a public information station in the galleries. A long-term goal is to have interactive systems to provide researchers with collections information, replacing the present cumbersome data print-outs. The museum has also considered several other possible projects: detailed recording of its tex-

tile collection, with a view to disseminating this information to other institutions; collecting on disc, images of North-West Coast Indian artifacts which are themselves no longer in Canada (a surrogate repatriation project); recording the museum's own, and other western collections, of Canadian Inuit and Indian artifacts, again for dissemination.

2.4 Applications in other institutions

Laser disc technology has such a wide range of applications that its use is by no means confined to the types of institution discussed above. Indeed, one of the heaviest uses of the technology is in the publishing industry, as laser disc (especially CD-ROM) is a very cost-effective medium for distribution of information. One of the more interesting publication efforts is the British Broadcasting Corporation's, (BBC), Domesday Project. Commemorating the 900th anniversary of the original survey of England, the BBC has issued two videodiscs containing 2,000,000 pages of text, graphs, and tables, 150,000 still photographs, and 20,000 maps; such a large database of course requires an interactive system - the whole thing will sell for about $2200.

Education is another field in which laser disc technology is already playing a large role, both in institution-based formal learning programmes and in industry-based training programmes. To select only one example, the Ontario Institute for Studies in Education, (OISE) developed, in 1983, two instructional programmes for videodisc, combining motion sequences, graphic illustrations, and computer-generated text. This was not an interactive programme, although in the same year OISE created interactive videodiscs to provide history tuition for Grade 7 students. Generally, the main advantage of optical information technology, for educational purposes, is its interactivity and its ability to accommodate self-paced learning programmes.

It is difficult to end even a selective survey of institutions using laser disc technology without mentioning the EPCOT Center - itself conceived as a showplace for new technologies. EPCOT has acquired a reputation for the excellence of its approach to provision of information to its visitors, and that approach relies heavily on laser disc technology, particularly interactive videodisc. A minicomputer controls some 200 disc players used to send information to numerous information kiosks and other presentation stations all across the EPCOT site. A notable feature of this system is its use of touch screen input of user-selections, necessary because few of EPCOT's visitors were expected to have knowledge of computers or to have keyboarding skills. Touch screen control of laser disc systems seems to be becoming increasingly popular, since it caters to very natural human mechanisms of selection. Touch screens are usually quite robust too, and so are useful in environments which present adverse conditions or where very high usage is anticipated - as would be the case in museum galleries.

3.0 FOUNDATIONS OF THE OPTICAL DISC PROJECT

Museum projects to implement optical information systems, in the past, have been undertaken carefully and with forethought, for the most part; museums have not experimented with the technology simply to find out what it can do, but have used it as a solution to specific problems, a way of attaining specific goals or meeting specific needs. Most of these needs and problems, identified in section 2 of this report, are common to museums, and this is no less true of the Canadian Museum of Civilization (hereafter the CMC), which views the laser disc as a vehicle not merely for performing one particular function, but as a general-purpose workhorse capable of providing responses to a variety of needs. This section of the report will explore those needs, and the responses envisaged thereto, in more detail.

3.1 Information resources management in the CMC

In the past there have been well-established routines in the CMC for collections management, scholarly research, and the provision of information to clients. Traditional collections management/research tools such as the card catalogue were for a long time satisfactory for servicing such functions. But since the establishment of separate National Museums in 1968, CMC's collections have been growing at a dramatic rate - they now number almost four million artifacts - with the result that traditional access tools have proven increasingly inadequate to fulfill the types of demands put on them. The process of identifying or selecting from the growing collections precisely those items which meet the requirements of staff or of external researchers has become increasingly more complex and more time-consuming.

Furthermore there exists the practical difficulty that CMC artifacts are in reality divided into four distinct collections, housed and managed separately, reflecting the museum's four academic divisions: History, Folk Culture (CCFCS), Ethnology (CANES), and Archaeology (ASC). It is not difficult to see how the mandates of these Divisions, in terms of their areas of interest and the types of artifacts they collect, are liable to overlap with each other to an extent; viewed from different perspectives, the same type of artifact might be of interest to more than one Division. And this has been the case. Yet their independence from each other - stemming in part from Divisions having (until recently) been housed in different geographical locations within the nation's capital - contributed to a communication gap; each Division is imperfectly aware of what each other has in its collections. Obviously it would serve staff curators, researchers, and exhibit designers better to know the full extent of all the collections. External researchers would equally benefit by such knowledge. These researchers might be involved in an historical study, or an anthropological one, or be folklorists, say, and would naturally approach that Division which most closely seemed to represent their area of interest. But, in using the resources of that Division, they might miss artifacts of potential relevance to their studies because they are held in other Divisional Collections.

An effort to improve the situation by imposing a degree of centralized storage of artifact records took the form of the creation of the Canadian Heritage Information Network, into whose database (PARIS) the CMC - one of the original participants in the pilot project[12] - has input many of its collections catalogue records. However, when a user performs a search

through CHIN and requires a print-out of the results, large printed lists (more than about 400 records) are made offline and mailed to the user. The time-delay involved in this process has proven increasingly frustrating, particularly in recent months as major work has been underway at CMC to assess resources, in the process of designing new exhibitions. Furthermore, textual artifact descriptions are not always the most convenient tool for making an initial selection of artifacts relevant to a particular project. Most staff prefer to have a visual representation of the artifacts to be scanned, along with very basic textual description, to narrow down the field before proceeding on to the full CHIN data and perhaps also images of better (publishable) quality. PARIS does not include pictorial information, although CHIN has experimented with a videodisc interface to its mainframe computer (with technically acceptable results), there would need to be fairly considerable restructuring of the overall system were videodisc services to be offered to PARIS users.[13]

A centralized repository of pictorial information on artifacts has been established within the National Museums of Canada in the form of a Photographic Services division. This acts as an archive from which copy prints can be made in response to requests from museum staff or researchers. Photographic duplication must be carried out via the facilities of the National Film Board, and the turn-around time for such orders typically takes two to three weeks - a delay projects often cannot afford, especially in the present circumstances, mentioned above. The cost of obtaining duplicate prints is quite expensive, particularly given that these pictures are only of temporary value until a selection of artifacts has been made.[14] Compounding the problem is the fact that although the centralized photographic collections are efficiently managed, within the limitations of what is an under-resourced division, by no means the whole of the artifactual collections is represented by photographs in the central repository. Some artifacts simply have not been photographed at all - similarly, not all of the collections are catalogued on PARIS - while others are represented by poor quality polaroid images or black- and-white photographs (in an age when users automatically expect colour images, and when the visual integrity of artifacts is a factor in the design of exhibits).

Nor do the artifacts themselves, the catalogue records, and the photographic collection, make up the whole of the CMC's information resources. Its mentafacts include substantial research and supporting reference materials maintained by each of CMC's scientific Divisions: manuscripts, unpublished reports, published works, machine-readable data, photographic slides, films, microfilms, videotapes, audio tapes, records, and cassettes, which are all important research collections. These supplementary collections are not subject to an equivalent centralized or automated control comparable to that of CHIN or Photographic Services, and are only accessible through hard-copy retrieval tools, if any such exist at all. To make those materials available for consultation consumes human and financial resources.

To take one special collection as an illustration: the Canadian Centre for Folk Culture Studies held (at the end of 1986) an audio collection of 5992 hours of material recorded on a variety of media: wax cylinders, paper tape, several formats of magnetic tape; roughly 50 hours of audio material comes in from the field each month.[15] In order to preserve the original materials, many of which have a limited lifetime or are too fragile to support frequent use, working copies must be made periodically and the originals kept in environmentally-controlled vaults. Copying is presently done on magnetic tape. Every four years the tapes in

the collection must be rewound, to provide proper tape tension and prevent physical damage, and every eight years new work copies must be recorded, as the existing ones have deteriorated to the point of unserviceability. Maintenance of this collection is expensive, both in terms of hardware, some of which had to be custom-built - such as a wax cylinder player, made for the museum by the National Research Council - and in terms of the cost of new tapes, which as it grows eats more and more out of the Divisional budget. It is also a labour-intensive process, to which only a single staff member (who has other duties besides) can be assigned due to limited Divisional resources; yet the collection continues to grow and demand for access to the audio information likewise is on the increase, from all segments of the public and from both inside and outside Canada.

Discussion of information resources management in the CMC has thus far focused primarily on the needs of staff and professional researchers. But there is also the general public to consider. Few are the museums which have the space to display all, or even the greater part of their collections. In the CMC, as in most museums, the bulk of the collections remain invisible to the visiting public, a fact of which many visitors are unaware. The same is true of the supportive collections, housed in Divisional documentation centres, or in the museum library, all of which lie behind-the-scenes and are not easily accessible to the general visitor. Thus there is a wealth of information to which the majority of museum users have, effectively (if not theoretically), no access.

3.2 The New Accommodation project

The opportunity for the CMC to address and resolve the problems discussed above came in June 1981 when the federal Cabinet approved, in principle, a plan to build three new museums to house the existing National Museum of Man and National Gallery of Canada, and a projected National Aviation Museum. The goals for this project included: the provision of facilities to support museum research and dissemination of information, and to enable the museums to carry out their responsibilities to scholars and other publics, in a more effective manner; and the provision of facilities offering better collections storage (in terms of environmental stability and security) than it was possible to provide in existing museum buildings. In February 1982 the Canada Museums Construction Corporation was set up to coordinate the various building projects, and in the summer of that year the National Museum of Man put together a New Accommodation Task Group to carry out initial planning for new facilities and programmes.

One target of early planning was the reformulation of institutional objectives in light of the challenge and opportunity of reviewing all aspects of museum operations and services. Expanding upon the museum's mandate to discover, preserve, and disseminate knowledge of human (and especially, but not exclusively, Canadian) achievement, museum management set out a list of objectives to guide staff assigned to planning duties. *The new museum should aim, it was decided, at providing the general public, scholars, educators, young people, and clients with special needs and interests with access to the collections, and to the knowledge which makes them meaningful, to the fullest degree possible and by a variety of means.* Public access to the national collections and to supportive information should be encouraged, and individuals and groups should be assisted in the effective utilization of these resources, but at the same time due consideration would have to be shown for museological principles of conservation and security of collections: access must involve minimal risk to the national treasures. The museum committed itself to using the most

modern technology, wherever appropriate, to carry out its objectives in providing and disseminating information on the collections; where possible, the primary medium of communication would also be translated into spin-off products designed for particular target audiences. The key to the educational role of the museum, it was felt however, lay in self-directed learning at an individual pace, and as far as possible in a participative fashion.

In less idealistic terms, planning teams quickly identified some central problems of the past - inadequate, inefficient, and fragmented access to collections information - and thereby determined the core needs for new facilities and programmes: to provide museum users with improved access to the museum's information resources in ways that did not jeopardize the well- being of the collections. Channels of access would have to:

- be readily and directly available to all;
- be faster than existing routes of information flow;
- be able to accommodate an anticipated increase in demand for information, a demand stimulated by the fact of a new museum, but also by the proliferation of personal computers and cheaper methods of data transmission;
- cut across the traditional Divisional barriers to provide an integrated database;
- cut across barriers of media format, so that artifacts could be easily linked with the supplementary information that helps interpret them. It was furthermore desirable that such channels be operating in time to assist the numerous exhibit design teams which would be at work during the later stages of the New Accommodation project.[16]

Various options for enhancing access to the collections, while protecting them from possible harmful consequences, were considered by CMC planners. Exhibit space in the new building will be much greater than that presently available, allowing a larger percentage of the collections to be displayed; and concepts such as typological or other artifact-dense subsidiary exhibits, open storage, or regular public tours of storage areas in automated people-movers, have also been explored. It should be stressed that the CMC does not seek to select one type of access from several options, but to provide as many different channels of access as is feasible, to cater to different levels of need. Yet the need is not always for direct access to original artifacts; very often information needs can be satisfied by providing intellectual access, to surrogates of the artifacts and to related documentation.

This being the case, it was necessary to identify one or more media that might do the job of providing surrogates. One partial approach would have been to create a comprehensive, high-quality, and highly organized photographic database documenting the collections. But such a project would have required, in essence, rephotographing all the collections, which would have cost in the order of five million dollars, while dissemination of such information would add substantially to that cost. Filming the collections in 8mm or 16mm format was similarly rejected because of the high cost. Videotaping offered the possibility of close-ups tied in with overall views of artifacts, and easy duplication; but again the cost was found to be fairly high, while the tapes (like colour film or non-alkaline paper) degrade physically unless kept in carefully controlled environmental con-

ditions. Microfilm, which has been used in the museum for data storage for many years, seemed a more flexible medium, able to hold copies of a fair range of media formats and produce displays of good resolution; but there was concern about aging problems, such as redox blemishes, while to provide fast (automated) access to microfilm-based information would require expensive equipment structures. For reasons such as those indicated in section 1.3 - efficient storage, multi-media handling capabilities, possibilities of automated retrieval and interactive programming, durability (without need for expensive storage environments), and general flexibility of applications - museum planners had little difficulty in settling on the laser image-capture process as the best available solution that was reasonably affordable.

3.3 Applications envisaged for optical information systems in the CMC

3.3.1 Collections management:

At the heart of the role laser discs can play in collections management is the fundamental issue of access versus preservation. These twin goals of museums have always seemed irreconcilably in conflict. To optimize the preservation of most types of artifacts it is necessary they be kept in special environmental conditions - often not the most comfortable of conditions to support human presence, nor always the best conditions to permit viewing - and necessary that handling be kept to a minimum. In fact, some items are so fragile that it is almost impossible to make them directly accessible to the public or to researchers at all. Yet to optimize access means placing the artifacts on view in areas whose environmental conditions cannot so easily be controlled, and making the artifacts available for precisely that tactile investigation that more rapidly brings about their deterioration. It would not be true to say that optical information systems solve this problem, for they are no true substitute for the display of the artifacts themselves; but certainly they offer a reasonable compromise: by providing pictorial surrogates of the artifacts, a greater percentage of collections-related information may be made accessible without putting the original artifacts at any risk. In many cases this type of surrogate access is sufficient to supply information needs. As one of the major goals in the creation of a new museum for the CMC was to improve public access to collections information, the capabilities of laser disc in this area were naturally very attractive.

Furthermore, for certain types of collections laser disc offers better possibilities for preservation than were previously available. Films, photographs, transparencies, audio and video tape, paper: all suffer some form of physical degradation, over the course of time, which is accelerated by use and handling. Although it is true that the physical media are in themselves a source of data concerning the development of information technology, the principal value of these collections is in the information recorded on the media. That information can be transferred to laser disc, which offers almost as good a quality of reproduction as the original media (and in the case of audio recordings, at least, the possibility ofidentical quality), a long lifetime, and sturdiness in the face of frequent handling and use. Also, when a collection comprises images fixed in place on a disc, problems of filing, refiling, and possibly misfiling, items within a collection are eliminated. This, as well as the improved retrieval capabilities offered by optical information systems, reduces the amount of time staff must spend in some collections management duties. A cost-saving may also be anticipated; for example, in the case of CMC the expense of maintenance (recopying) of the audio collection and of obtaining working

prints from the photographic collection will be significantly reduced.

Further implications of the use of optical information technology for collections management may also be mentioned. Conservation staff at CMC have shown great interest in utilizing disc-recorded images of artifacts to provide hard-copy images to increase the productivity and quality of condition reporting (presently condition reporters must resort to drawings), as well as to evidence the number and types of repairs made over the years to any given artifact. There is also the possibility of using laser discs as a repository for x-ray images produced by conservators. Again, a disc-based collections catalogue can serve security needs by providing a comprehensive, easily accessible, and distributable record of collection contents.

3.3.2 Research support:

An efficient catalogue-type tool for collections management is obviously desirable to serve the needs of collections researchers, whether it be staff or external researchers. Again most needs can be served while at the same time reducing the necessity of researchers having direct, and potentially damaging, access to the artifacts themselves. At present researchers, without going to the original artifacts, are faced with documentation (catalogues, photographic collection, Divisional archives) that is not comprehensive, is fragmented between Divisional units or between separate collections of different media-types, or entails some delay in obtaining the desired information. Laser disc technology offers the possibilities of: very fast (computerized) retrieval, thus reducing the amount of labour in the initial stages of research; an ability for swift scanning, or random accessing, of disc-based information, again reducing the effort necessary to identify the items in the collection appropriate for detailed study; and integrated access to textual and non-textual information sources, as well as to the total museum collections, thereby catering more effectively to inter- or multi-disciplinary studies. A good deal of time is spent by researchers just identifying and seeking out material relevant to their work. By speeding up the access to such information more time can be left to researchers for the actual study of information retrieved - thus making the research, hopefully, more productive. In other words, museum resources are used more effectively.

It is worthwhile to stress again, here, the particular value of laser discs as a repository of multi-media materials. One of the major difficulties with textual catalogues of museum collections is that words cannot entirely adequately represent a visual medium. At the same time, an image of an artifact can rarely be entirely comprehended without some form of supplementary information. In traditional collections management systems it has been impractical to locate supporting documentation to allow for its concurrent study with the objects documented; photographic images attached to catalogue cards are often of low quality, and such images are lost if the catalogue is computerized. Interactive laser disc systems offer, CMC believes, the most cost-effective means for integrating pictorial representations of artifacts with supporting documentation. The larger the collections involved, the more efficient, comparatively, optical information systems are.

3.3.3 Exhibit design support:

One special type of collections research is that which staff members involved in exhibit design must undertake. Presently, in order to determine which artifacts are most suitable for supporting a particular exhibition theme, staff must use the somewhat cumbersome manual catalogues and other registry information, or, if they have to wait for the same data from CHIN, work their way through long print-outs (al-

though some teams have managed to make do with short online print-outs); then, in order to assess the visual impact of the artifacts in their initial selection, they must either search the storage areas to find the artifacts themselves or wait for the production of duplicate prints from the photographic collection - assuming the artifacts under consideration have been photographed at all. It was not hard to see how laser disc based collections information could reduce the effort, time, and cost in this process by making all relevant information available from a single, comprehensive source, at high speed of access. Again the result: greater efficiency, greater productivity.

3.3.4 Public programming:

The use of optical information systems as a vehicle for audio-visual presentations supporting artifactual exhibits has been well demonstrated in a number of institutions. Many of CMC's permanent exhibits incorporate such presentations, utilizing slide projectors, videotape players, or 16mm film loop units. The maintenance and repair of this equipment, as well as replacement of the software it utilizes, which deteriorate quite rapidly under conditions of daily use, are expensive and labour-intensive. The lifetime of hardware and software is liable to be further shortened if visitors are given ways of controlling the presentations; such control is desirable but not very effective due to the length of time taken to move about between different segments of a presentation. Laser disc, on the other hand, suffering no ill-effects from extensive and continual use, is an excellent presentation vehicle; its playback equipment also has a reputation for being comparatively maintenance-free. Moreover, the high storage capacity of laser discs can permit a much larger number of still images to be shown, making it possible to bring visual information on a much greater number of artifacts (most of which are hidden away in storage areas) to public viewing areas. Discs offer if not a perfect at least a viable substitute for typological displays ("online exhibits"?), thus catering to that level of visitor interest without taking space away from thematic exhibits. Although laser disc systems are not always a better means of presentation than traditional forms - multi-screen slide shows, for example - on the whole they offer cost-reductions and greater flexibility. Part of this flexibility comes from the ability to mix media on a disc, so that productions can include still images, textual interpretation, motion sequences, and audio. The possibility presents itself of bringing into the public areas many of the resources previously restricted to the curatorial areas; not only the artifacts, but catalogue information and other supportive documentation of various types.

The presentations provided via laser disc can be purely linear, as is typically the case with many of the traditional systems. And of course the introduction of a new technology does not necessarily change the types of problems designers must account for when introducing audio-visual elements into exhibit areas: for example, how will traffic patterns be affected, to what age(s) or educational level(s) of audiences will the presentations be directed, how many visitors per hour are likely to pass through the exhibit (and potentially want to see the presentation), should the presentation be a sit-down or stand-up type? A strictly sequential presentation does not take advantage, however, of one of the best advantages that laser disc systems offer: interactivity. It is well-established that the learning process is generally most effective when it is self-paced and when a participative element exists in the process. Laser discs cater to both needs. An interactive laser disc system, at an individual work-station, allows the user to select, via menus, precisely those segments of a disc (i.e. subject-areas) which are of most interest, and to view them in whichever order desired, reviewing segments repeatedly if

the user feels the need. And the freeze- frame, slow motion, and scan capabilities of the hardware - all under the user's control - permit either more detailed study, or bypassing of any information on the disc. The user thus exerts more direction over his or her learning experience. Museums have long appreciated the value of interactivity, as witnessed by the use of interpretive staff stationed in the galleries. For repetitive communication, however - many visitors asking essentially the same questions - and given the capability of laser discs to hold enough data to answer a lot of questions, optical information systems are able to serve many clients' needs for information. They should not be thought of as replacing live interpreters, but as providing a means whereby more visitors can be served, for few museums can afford to provide the number of interpreters that they might wish. While it is true that a machine lacks the warmth of a human interpreter, some visitors feel embarrassed at taking up too much of an interpreter's time, or indeed at approaching them at all. Mechanical sources of information are perceived as non-threatening and also as available for in-depth exploration of a topic. It is no coincidence that interactive optical information systems are increasingly widely used by schools and by academic institutions, in formal educational programmes, and by government, the military, business, and industry for a variety of training purposes. The use of interactive video in education has been found to increase retention rates by about 30%, and to halve learning time.

One reservation here should be noted: that laser disc presentations are frequently, although not necessarily, geared towards individual users, and certainly individual use is preferable for interactive capabilities to be exploited effectively. Yet the CMC has found that most people visit the museum in groups, not individually, and it is hard for members of those groups to break free for extended periods; the attention-span of such breakaways seems to be, on average, just under a minute. Thus it is anticipated that, in the CMC galleries, kiosk-based laser disc presentations will not be extensive and will not involve a great deal of interactivity. Stations for more in- depth study of disc-based information will be provided in other public areas within the museum. The type of system anticipated for the galleries would be similar to that which has been used at EPCOT (based on Bell's ARIEL system) or at Expo 86 (the IBM InfoWindow system) and may well use touch-sensitive screens as an input device.

For public programming requirements, it is not anticipated that copies of the archival-type discs developed for collections management purposes be used. Although sophisticated programming would certainly allow elements from the archival discs to be combined in any desired order to provide customized programmes, the simpler route is rather to use the archival discs as sources for the production of thematic discs designed to support specific exhibits. A linear presentation is easily developed simply by selecting the desired images from the archival disc, and re-ordering them on the exhibit support disc; one disc will hold presentations for several, or perhaps all, exhibits, depending on length, and copies can service the individual information kiosks in the galleries. For the production of interactive presentations authoring systems have been developed commercially to facilitate the task of the producer, or author. These systems, designed for persons with minimal experience in computer programming, offer a menu-driven method for arranging the complex sequences of display, user interrogation, response analysis, and branching (which allows the producer to set up various paths through the presentation depending upon which responses the viewer gives to the interactive system's questions, thus enabling presentations to be tailored for different levels of knowledge or skill).

3.3.5 Dissemination of information:

Once an original master-disc has been created, it is relatively easy and relatively inexpensive to produce copies which can be made available, by donation, exchange, loan, or sale, to other institutions, as a means of sharing informational databases nationally and internationally; pictorial databases in particular have that capacity to transcend national, cultural, and communicational barriers. And it may be borne in mind that one of the best ways of preserving information is to disseminate it. It can well be imagined how the distribution of such databases will have a beneficial effect on research; it can facilitate the efforts of researchers by providing easier access to the information they need, and may stimulate research that would not otherwise have been practicable due to the amount of travel necessary to various museums.

The copies need not be restricted to other institutions but made available for purchase by individual researchers or members of the public; museums are beginning to discover a growing market for laser discs. Publishers are already moving quite heavily in that direction, partly because discs are very cheap to replicate in large numbers, while their light materials and compact size make them cheap to distribute by mail.[18] As an increasing number of discs appear on the market, so more consumers are willing to invest in playback machines, in turn providing a larger market to encourage publishers. It is in this area of mass replication and dissemination that laser discs really prove themselves, economically; the larger the number of copies, the cheaper the per-unit cost, and the greater opportunity to underwrite or even recoup the initial investment in the technology. There is also the consideration of the use of disc copies in outreach programmes.

In a sense dissemination of information via the production and distribution of multiple copies of master discs may be considered a by-product, a spin-off, of the main objective of the project. Yet when the value of decentralization and democratization of records of our cultural heritage is so enhanced, and when it is considered that one of the core responsibilities of museums is communication, the dissemination function seems of far greater importance.

3.3.6 Médiathèque

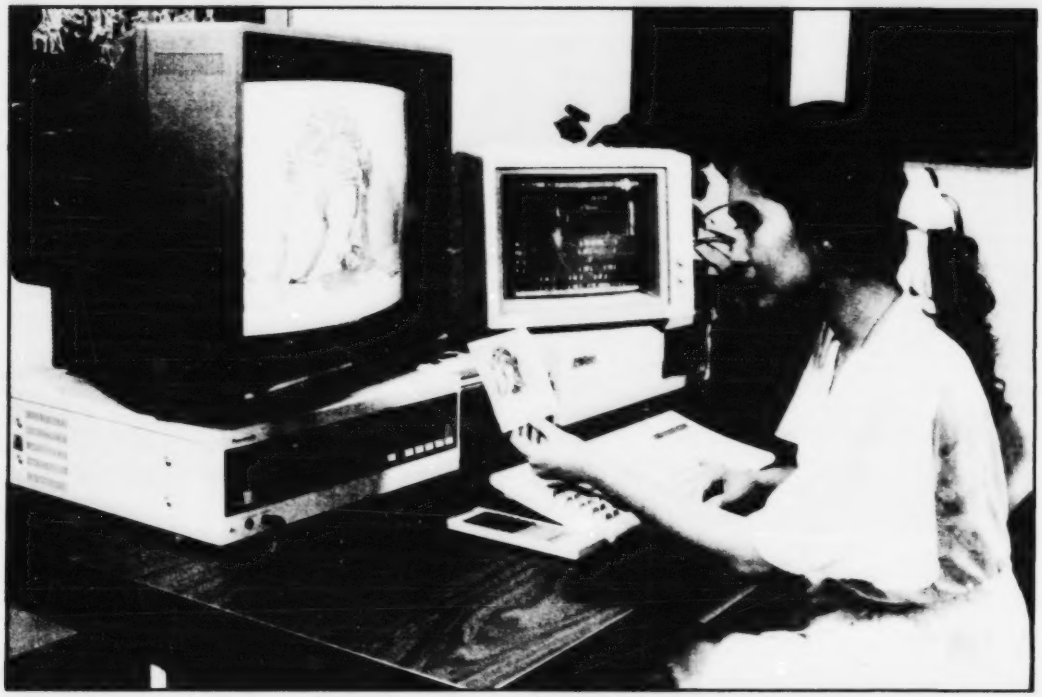
As was indicated in section 3.3.4, the limited attention-span of visitors in the galleries themselves makes it necessary to keep laser disc interpretation there brief. To cater to visitors who wish more detailed information, and have the time to spend at in-depth study, a museum resource centre, "Médiathèque," is planned for the new CMC. In the early stages of planning the new museum facilities it was felt that the anticipated increase in demand for information about CMC collections and activities required a central facility which could directly provide information catering to a range of levels, from general interest to casual research, and act as a referral centre for serious researchers whose needs require contact with Divisional staff or with the collections themselves, or for special interest groups seeking a presentation from a staff expert. It was in the context of searching for the best information storage/delivery system for the Médiathèque that optical storage technology was first given serious consideration; interactive videodisc was soon accepted as a major element in the Médiathèque system.

Initially it is expected that the Médiathèque will offer an assortment of interactive videodiscs - tailored from the masters produced for collections management - geared towards specialized subject-themes, such as musicology or Inuit art; special interest groups will be identified and programmes developed for their particular needs. In addition, copies of the com-

prehensive masters can be made available. In the long-term these may be supplemented by discs holding Divisions' supportive documentation on the collections: registry records (with sensitive information, such as purchase price, present value, precise location in storage, edited out), research reports, and so on. Thus the Médiathèque will offer the efficiency of pooled services and the majority of information needs can be satisfied without the inquirers having to enter high security Divisional or storage areas. Consideration is also being given to a separate Senior Study Centre strictly for adult users interested in in-depth research.

3.3.7 Promotional applications:

Although there has not yet been serious planning in this direction, the experiences of other institutions show a potential in laser discs as public relations and fund-raising tools. Laser disc offers a convenient medium for distribution of information about the museum, its collections, services, etc., presented in a form that can be at once dynamic and enjoyable. The same type of information can be used in tools for orientation of visitors when they arrive at the museum, or at local tourist information centres.



A member of CMC's staff conducts collections research on the interactive optical disc system.

4.0 THE PILOT PROJECT

4.1 The Project Initiation Proposal

It was the Operations (curatorial) component of the museum which first became involved with optical storage technology, beyond merely the conceptual planning stage. A project, under the title New National Museum of Man Videodisc Project, was set out in a meeting of August 1983, chaired by the Assistant Director, Operations, but at which museum staff were joined by representatives of the Corporation's Photographic Services and of CHIN. There followed one and a half years during which research was conducted on optical information systems, from the viewpoints of applications in other institutions and equipment structures available from manufacturers; during this time the bias of the project moved away from videodisc technology and more towards optical digital technology. It might be added that this research already had a foundation on which to work in the form of studies previously conducted by the Canadian federal government, notably an extensive interdepartmental study of optical storage technologies carried out in 1981. In February 1985 a project profile was laid out, and expanded into a formal Project Initiation Proposal (to initiate a feasibility study) two months later; in this process both staff involved in collections management and those involved in exhibit development participated. A project team was put together and four months of study was subsequently carried out.

4.1.1 Objectives:

The overall purpose of the feasibility study was to undertake a broad-based, hands-on[19] investigation to examine methods and applications that could improve on the speed and efficiency of access to information at a reduction in cost, or at least no significant increase, over present methods; also, to identify the system parameters that would serve this purpose and at the same time provide for a maximum number of applications within the museum. Functionality and quality, relating to specific museum requirements, would be demonstrated and evaluated; although many of the benefits of laser disc systems had been shown by other North American institutions, it was considered desirable to evaluate those factors within the specific framework of CMC conditions and needs.

The goals established for the study project were:

- To integrate basic textual data and visual representations of artifacts in the collections, in such a fashion that a user could browse visuals and be automatically connected to textual data relating to any visual selected, and vice versa.

- To provide a suitable secondary format for a range of materials requiring special measures to ensure their preservation, due to their fragility, rarity, or high use.[20]

- To test the linking of tombstone data (i.e. skeletal records containing the basic information required to meet the needs of collections management staff or researchers) to disc-based images, and to test a microcomputer with simple database management programmes to handle this textual information.

- To produce a variety of laser discs - in both Universal and DRAW formats - to determine and compare the quality, flexibility, and cost-effectiveness of each type, and its associated hardware, with regard to the museum applications envisaged.

- To identify a system capable of meeting the needs of the museum at an affordable cost.

4.1.2 Project participants:

Participation in the project, at one level or another, was fairly wide-ranging. The original project parameters were developed via consultations with staff from both the curatorial and public programming components of CMC, and with representatives of other components of the National Museums of Canada, such as CHIN, the National Museum of Science and Technology, and the National Museum of Natural Sciences; the hope was that the end-result of the project might be something of general value to the museum community, not a system of use just to CMC. Several bodies were to cooperate in carrying out the project. CMC would provide the operational staff, funding, laser disc equipment, and facilities. NMC Photographic Services would make available negatives, prints, slides, microfilms, and x-ray negatives relating to the artifacts selected for recording in the project. CHIN would supply the textual information on those artifacts from its database,[21] would provide a microcomputer system, and staff to work on a consultative basis with equipment suppliers in the development of the interactive structures. The CCFCS Registrar and his staff were to edit into tombstone form those CHIN data print-outs which related to the particular collections for which they had responsibility. And the National Film Board's (NFB) Montreal-based Multi-Media Project unit (Studio D) would experiment with the process of recording and with film types that might produce the best quality master-tape for transfer to videodisc; much reliance was placed on their technical skills.

The daily recording operations were to be carried out by a three-person team provided by CMC. One member was the project manager, responsible for budgeting, scheduling, quality control, project liaison (with Divisional staff, to plan for their specific requirements and work out the flow of materials to be recorded on disc), and supervision of the two technicians on the team. One technician was responsible for controlling/inputting the computerized data to be interfaced with the disc images, and to work with the video technician in ensuring maximum image quality and consistency. The other was to operate the laser disc equipment and related television hardware, as well as to ensure studio lighting control equipment was properly adjusted for each image being recorded. The overall project team comprised the above persons (the first acting as team leader), as well as one representative each from Photographic Services, CHIN, and NFB. Besides this core team, a secondary group contained representatives from various components of the National Museums of Canada, to discuss developments and provide reaction to demonstrations.

4.1.3 Project components:

As originally conceived, the project would encompass four distinct components. However, for reasons which will be elaborated upon in section 4.3, it was not possible to proceed with, or to complete, all components within the timeframe of the study, which was from September through December of 1985. The sub-projects in the study were:

- The production of two Constant Angular Velocity videodiscs, by different

methods, in order to compare the quality of images produced. CAV-1 was to involve the NFB processing photographic materials related to CMC collections and transferring the images onto a single film-strip, in such a fashion as to determine the maximum image quality possible. The film would then be pre- mastered onto 1" tape, which would in turn be used to produce a "check" videodisc [22] and subsequently (if results were acceptable) a CAV master disc. The costs of this component were projected to be: $5,200 for transferring the filmstrip to tape (by a commercial operation), $600 for the preparation of a check disc, and $3,500 for production of the final disc; the cost of processing the original materials was to be absorbed by NFB as part of its research mandate. CAV-2, using some of the same original photographic materials as CAV-1, would employ a local commercial facility to make a master- tape, before a check disc was prepared.[23] The costs here were projected to be $3,400 for transfer of slides to tape, and $600 for the check disc.

- The use of DRAW systems [see section 1.2] to produce, in-house, optical digital discs, by direct recording of images from artifacts or photographic materials. Analogue videodisc systems had been on the market for some time, and it was felt that, in using them for the project, the principal aim should be to investigate, comparatively, image qualities. Digital discs were more of an unknown quantity, but seemed to offer larger capacity at lower hardware costs, hence the intention to explore this avenue of approach more deeply. Two makes of DRAW equipment were selected from those on the market (for reasons explained in section 4.3): a GEAC-Thomson system, costing $1,000 per month to rent (or outright purchase for $29,000), and a Control Data system with rental at $2,200 per month (outright purchase US$21,950, and software development $2,500). It was to these systems that a microcomputer interface would be made, coupling to the artifact images the tombstone records derived from PARIS data. The particular focus of this component of the project was to compare hardware costs and capabilities.

- The transfer of the Divisional audio collections to digital disc.

- The use of DRAW discs to capture visual information required by the exhibit development teams. By employing a variety of approaches and equipment structures the study was intended to generate a corresponding variety of video product formats and levels of quality; end-users (i.e. museum staff) could then be asked to decide which format best suited their needs, based on image quality and labour/equipment costs.

4.1.4 Resources and facilities

Artifactual material was selected for the study on the basis of availability of images and state of documentation. CCFCS collections were chosen to be the focus of the project, since a higher percentage of good-quality photographic materials existed for this than for other Divisional collections, since the Division was highly concerned about finding a way to reduce its backlog of photographic work, and since CCFCS' technical staff possessed some expertise concerning laser disc systems.

Photographic images rather than artifacts themselves were used for recording (except in a very few cases). The source- images used were principally of: artifacts that had been part of museum exhibits (*From the Heart, Works of Craft, The McKendry Quilt Collection*); musical instruments and duck decoy collections; 16mm film of the weather-vanes collection (specially shot for the pilot study). In order to test an array of original materials, other National Museums components (other museums, the Canadian Conservation Institute) were approached for items such as x-ray prints; slides were the principal source of images, however, and to a lesser extent microfilm and negatives. Approximately 2,000 images were used in the study to evaluate the transfer potential; these documented roughly 1,400 artifacts, with some artifacts being represented by more than one image. It was decided not to go to the expense of setting up a special video lab for recording, using the DRAW equipment. But a high quality video camera was needed. Telecine equipment could have been employed for image transfer - a Rank Cintel Flying Spot Scanner, for example - but such equipment is very expensive and requires a skilled operator to produce quality output. CMC's approach was to project images onto a screen and view them with an Ikegami HL-77 camera, the output being monitored on a test rack of Tektronix equipment to ensure a good video signal was being provided to each piece of equipment. All makes of equipment tested received the same video signal during operations; equipment suppliers expressed satisfaction with the quality of the image made available for the tests.

4.2 The videodisc sub-project

The NFB, in its part of the study (CAV-1) chose to experiment with a process involving the transfer of all image formats provided onto a single medium: film-strip. This is a comparatively exacting and costly process, involving balancing the colour and matching the contrast levels of the source visuals to produce controlled quality images on the film-strip. A variety of source visuals - slides, 16mm film, negatives - were to be tested to determine the type that best produces the kind of image most suitable for the videodisc route.[24] The aim was to engage a number of New York production houses to test the transfer to master-tape, and use the house providing the best results to produce the tape from the final film-strip; subsequently this tape would be sent to the 3M plant for producing a videodisc.

Unfortunately, technical problems with NFB camera equipment, and the need to share equipment with other NFB users, delayed this part of the project; it could not be completed within the study's time-frame. This was disappointing but not considered a serious setback, as it was anticipated that the CAV-2 project, utilizing a local company to carry out standard processing of slides (as opposed to NFB's controlled quality approach) would produce a result satisfactory for serving many of the CMC applications envisaged; the controlled process was felt to be desirable for the production of discs to be sold to other institutions or to the public. As the plan was to put the master-tapes produced by CAV-1 and CAV-2 onto the same videodisc, for easy comparison, this part of the project was also affected by the delays at NFB. It was not for about a year after the pilot study was commenced that NFB was able to continue with their part of the work. A videotape showing the first sequencing through the NFB process has been received by CMC. Results so far are not as impressive as had been hoped. In particular there is a problem matching the format of source materials (notably slides) to videodisc format. Slides do not conform to the 3x4 television ratio. As the CMC slides mostly had their images in horizontal format (i.e. to be viewed with the longest side horizontal), NFB modified the transfer lens on their scanner to

accommodate slide dimensions. For vertical format images the problem is further compounded. In either case, but particularly the latter, there are inevitably borders on one or more sides of the disc-version image. Presently this border is black. However, the black border - and in fact any coloured border, testing has shown - will interfere somewhat with the slide image, producing visual slurring. Neutral grey (which is in fact the lack of colour) is the only border compatible - that is, non-intrusive - with the image colours. Therefore NFB is developing a computer graphics programme to insert grey borders around the images.

4.3 The optical disc sub-project

Following research into different manufacturers' systems, during 1984, eight companies were invited to make bids, and two digital DRAW systems were selected for testing. The reasons why other companies were eliminated from consideration were basically one or other of the following: the equipment was extremely expensive; the equipment was really still in the developmental stage; the equipment was not available for rental. What CMC was looking for was off-the-shelf systems that could be rented for the trial period. The original intention of this part of the study was to focus on digital systems, because there was a great deal of hype surrounding the quality of this technology, and because prior experience in the museum with analogue videodisc had provided images no better than those viewed on a good television set. Consideration of analogue systems was therefore to be restricted to the CAV sub-project. However, when the museum was offered the use of a Panasonic analogue DRAW system for the test without rental charge, it was decided to take advantage of this circumstance.

4.3.1 Digital DRAW:

The two interactive systems selected for testing were:

- the Control Data OSI-1200 system, using a Scion video input board, a Zenith (IBM-PC compatible) microcomputer, and a Ribigital board to control the OSI LaserDrive 1200 Intelligent Digital Optical Disk Drive. The disc recorder uses 12" discs, capable of holding one gigabyte of data. As the laser burns holes through the metallic information-bearing layer, encased in glass, recording can be made only on one side. Digicolor and Mongoose were the routines used with this system.

- the GEAC Computer G1000 system, using a Chorus input board, and IBM-PC microcomputer, and a Vectrix board to control the Thomson-CSF Gigadisc GD1001 laser drive. The recorder uses 12" discs again of one gigabyte capacity per side; but as both sides of the disc can be recorded on, total capacity was 2 Gb. PC-Eye and Vices routines were used with the computer system.

A number of technical problems with the computers used in both systems resulted in delays in the museum getting access to the equipment. There was, nonetheless, time during the project to record a series of images on the systems and evaluate the output on the two discs produced.

Control Data's selection of system components - there being many boards from which they might have selected, for example - made

for fast image-capture and a flexible operating system; that is, many options to permit the setting-up of custom programmes for the end-user. The flexibility of the software used would provide a variety of menu screens for museum purposes. The equipment also produced quite good (but no better) resolution.[25] However, some degradation of image quality was experienced during the course of the testing. There was a problem with the Scion board overheating, which it was never entirely possible to overcome, and this may have been the cause of the image problem. The board also produces an RGB type of video signal,[26] which made it impossible to monitor the image using standard television equipment. On the whole the digital image produced was not considered satisfactory for critical review of artifacts or graphics for research purposes, although it might have proved adequate for the more casual needs of the general public. Furthermore there was no existing programme which would interface the images produced with the CHIN data; the programme it was proposed to use (B-Trieve) could have been modified to do so, but this would have added the cost of one month of programming ($12,000) to the project budget.

GEAC were sufficiently confident of the ease of operation and superior picture quality of their system that the museum was given an inexpensive rental rate. But from the beginning difficulties were experienced, initially in setting up the equipment at the museum. When this was finally achieved, the digital image quality was very poor. Unfortunately, at this crucial point key staff in the Ottawa office left the company. Electronic component failures resulted in a number of problems in operating the system. Input video could not be viewed in colour, which obstructed adjustment of the signal for image enhancement, colour balancing, etc. Consequently it was necessary to check the recording results for every screen, and as many as 12 copies of the screen had to be produced in order to fully develop each frame image. It took about 20 minutes to produce an acceptable frame, therefore. There was also difficulty retrieving images from the disc after recording, although the prior process of digitizing an image and storing it on computer was accomplished successfully.

To be fair to both these companies, it must be stressed that they were primarily in the computer market, and the development of optical disc technology for a video application was a learning experience for their programmers and engineers. The selection of faster computers and different boards might have produced quite different results; digital DRAW units were designed to substitute for tape-drive or hard-disk units in the interfaced computers, and image processing boards are not a fixed part of the system. GEAC indicated, subsequently, their dissatisfaction with the equipment structure they chose, and expressed an intention to use an INTEL minicomputer in future to speed up the image transfer process. It may be said that the final video quality produced by the GEAC system during the test was quite acceptable; the problem with it was the difficulty and time in achieving the image. It should also be borne in mind by the reader of this report that the pilot occurred in late 1985, and the equipment therefore pre-dates that time. GEAC and Control Data have had more than two years to correct the problems with their equipment, and to take advantage of new boards coming onto the market having better quality pixel resolution. The information in this report cannot therefore be valid as a condemnation of the present systems marketed by those companies.

4.3.2 Analogue DRAW:

The analogue equipment fortuitously offered to the use of the museum was the Panasonic TQ-2020 Optical Memory Disc Recorder (OMDR), which uses an 8" disc to hold up to

15,000 still video frames. Setting up and operating the system proved comparatively easy, as the output from the video camera could be sent directly to the OMDR (although in fact it was fed through the monitoring equipment first),[27] rather than through a computer as in the digital systems; this meant that recording was in "real time". Input was found to be accomplished quite quickly: roughly one frame every five seconds, with minimal need for video correction for variance in the slides being copied. About 1,000 images were recorded on this original OMDR, and then the opportunity arose to acquire a new Panasonic machine, the TQ-2023 Motion Video-Audio/Still Video OMDR. This used a new disc which, although still 8" in diameter, provided greater capacity, of 24,000 frames (the digital systems being able to hold only about 4,000 images, due to the space consumed by a single digitized image) or 13.3 minutes of motion film.[28] Each frame could be accessed during playback in about half a second. It was decided to use the high resolution TQ-2023 to compare the quality of image with the standard TQ- 2020, and a further 400 images were recorded, with a significant improvement in quality.

Later an even higher resolution was produced after a local firm made modifications to the OMDR (relating to the method of electronic control of the input signal) - an improvement Panasonic declared it would incorporate into all its machines. The image quality of the analogue system was clearly superior to those of the digital systems; there was the further advantage that playback units for the analogue system (viz. the TQ-2024) were available separately, at considerably lower cost than the recording unit, which would mean reduced costs over a digital system in a situation requiring single-location recording but multi-location playback.

4.4 The exhibit design support sub-project

The testing of DRAW systems for capturing the visual information required by the various exhibit design teams planning for the new museum was originally intended to be undertaken after the other DRAW and CAV components were completed, an extra two months rental of equipment being anticipated. Discussions with personnel on these teams had already suggested certain avenues for exploration. To take one example, a team working on the design of a crafts exhibit indicated the need not merely for rapid access to images of artifacts, and related text, but also the need to know the measurement between any two points on the artifact. It was felt that the computer in an interactive system might be used to calculate distances, by the user touching any two pixels on the display screen with a light-pen and the computer using that information and the overall artifact measurements (on the tombstone record) to calculate the measurement of the area of the artifact between the pixels.

No opportunity to test applications such as the above has yet arisen, however, since the exhibit design teams are only now reaching the stage where they can consider how they will use an optical information system. The output of the pilot project has, nonetheless, shown a number of options that could be used by the exhibit design teams, and it is expected to pass on to them the pilot's demonstration discs in February 1987.

4.5 The audio collection sub-project

The rationale behind this component of the pilot study was explained in section 3.1. To reiterate briefly: maintenance of the CCFCS

audio collection is expensive and labour-intensive. Divisional experimentation with digitized audio led staff to consider digital optical disc as a more efficient and cost- effective way of storing and automating (for retrieval) the audio copy collection. This would remove the need to rewind and recopy tapes, the present storage medium, periodically, and the transfer process to digital form would in fact allow sound quality to be enhanced by processing out extraneous noise. The longer lifetime of discs than tape would allow a reduction in the frequency (and therefore the cost, in time and material) of recopying. Furthermore, the compactness of discs would result in a reduction of collections storage space from 640 sq.' to 1 cubic meter, it was estimated.

The original system considered for this sub-project included: the OSI-1200 digital optical disc recorder, then priced at $25,000; a Micro Technologies Sound16 ADA, for interfacing the audio equipment to the digital unit ($8,000), and an IBM-AT with conversion programme ($8,000). It was hoped to get 1,000 hours of sound onto one $600 disc, saving thousands of dollars in the cost of audio tape. However, as elements of the equipment structure were not sufficiently developed for marketing, and due to the total cost of the equipment, the audio collection sub-project was dropped from the pilot project.

It was revived, however, a year later when there appeared on the market the Compusonic Recording System, a unit using 5.25" compact discs. The recorder was priced at US$7,000, which compares to $80,000 worth of equipment presently used to record audio tapes (and this equipment is aging and will soon need replacing). Each disc holds 512 minutes of audio, and it was estimated that CCFCS would require about 750 discs, allowing for collection expansion over the next few years. At $100 a disc, this compares favourably to the cost of tape ($204 for 512 minutes worth), especially given the need for more frequent replacement of the latter. It is intended to proceed with this project and in time, as with the discs holding the visual images, the audio discs will be made available for public consultation and edited versions will be produced for various purposes.

4.6 The interactive element

With the visual information on the artifacts completed for the DRAW sub- project, attention turned to ways of providing the user with access to the textual data to be linked up with the images. The linking of a computer to a laser disc recording and/or playback unit in an interactive system was to serve two basic purposes:

- To provide an efficient and flexible retrieval tool that can accommodate a large disc-stored collection of information items, each of which may need to be accessed independently and randomly. A stand-alone system cannot provide the detailed indexing that is required to allow users to narrow down a search to one specific item from many thousands.

- To provide textual information, stored by the computer, that can be updated or otherwise changed if necessary (whereas textual information recorded on laser disc is fixed and unalterable), and that can be automatically retrieved by the user in conjunction with the related images retrieved from the laser disc.

Optical storage hardware is commonly equipped to accommodate interfaces with computers. The digital DRAW laser drives tested both had SCSI interfaces,[29] a standard for those types of drives, while the Panasonic

OMDR was equipped with an RS232C serial port for interfacing.

The different equipment structures necessitated testing of a number of computer programmes, able to command a second piece of hardware (i.e. the laser drive) and accept from it a field reference that would enable the computer to call up the textual record bearing the same reference. The computer boards used in the two digital systems were different and required different language structures; the programmes used with these, relating to image creation, have already been mentioned [section 4.3.1]. A Sony LDP1000 universal videodisc player was used to demonstrate basic principles of interfacing, using a programme called Image Search, designed to allow rapid access to videodisc images. The programme permits the user to define up to six search parameters before search is undertaken and a "hit-list" presented; when the user selects an item from the list the image is retrieved on one screen and the textual information on a second. The programme can be customized to fit different applications.

With the analogue DRAW system VMAS was the programme tested; this functions similarly to Image Search except that the user is also able to scan the images, select one, and automatically call up the text, or to browse the text and similarly call up related images. This two-way process is exactly what most researchers need when seeking information on museum collections. More general programmes, such as dBase III, were experimented with too. All required modification in order to have the textual database tied in to the laser disc package. It was found difficult to retain an image called up from a disc when the user switches to a file containing textual records. Overall the database management software tested provided most of the basic functions needed, but most packages would have required some modification to make them suitable for the envisaged CMC applications. It should be noted, however, that use of commercial database management software to accompany a laser disc, in a situation in which the combined package might be made available for public purchase, would require licensing agreement to be made with the software producer to allow redistribution of the programme without infringement of copyright laws.

A number of alternatives were also considered with regard to the storage location and method of viewing the textual data. It had already been decided that this data would be in the form of a tombstone record, an edited-down version of the records on CHIN's database. The easiest route with digital optical systems would be to record the data fields on the disc, along with the images; the data would be dumped into the microcomputer's memory by the user each time a search was begun. This approach would sacrifice the ability to alter the data subsequent to recording, although the likelihood of this need was not great. With analogue systems other options are preferable. An experiment showed that the audio track of an analogue disc could be used to hold textual data. Simply employing a modem to modulate the digital data into a signal which could be stored on the audio track, and then dumping it out (again through the modem to demodulate the signal) into the microcomputer whenever a search was to occur, was found to be quite workable; 2400 baud, a rate popular with microcomputer users, proved suitable for the purpose. As there are two audio tracks (for stereo), one could be used for English- language data, the other for French-language data. The drawback is limited storage space: in order to allow each image its own record, a record could have only half a dozen fields.

Floppy disc was considered as a repository for the textual data, but the amount of data in-

volved would likely require quite a few floppies of 360k size, and to go to 1.2meg floppies would have made the CMC package unavailable to microcomputer owners whose machines have only 360k disk drives. Hard-disks have the capacity needed, but most are not distributable. A hard-copy image index and print-out of textual records would have been easy to provide, as a manual reference tool, although would have increased the expense of distribution; but this ran counter to the goal of automation to optimize access speed. A further option was for disc users to download data directly from CHIN into their microcomputers, using a modem. This type of operation had already been demonstrated to CMC by CHIN, and was not replicated during the pilot study.

Other aspects considered were the possibility of overlaying textual data on top of the graphic image, on a single screen, and ways of obtaining hard-copy from disc-based images. In the former case overlaying was found to be perfectly feasible, but was rejected as a normal approach because the text took up too much room on the screen, obscuring the artifact image from view. It was felt desirable, however, to have the capability of overlaying at least the frame number on the image, and perhaps of giving users the option of either overlaying the whole text or having text and image on separate screens. As regards the hard-copy question, it was determined that:

- A number of types of image printers, providing polaroid pictures of a screen-image, are on the market; these have high quality output, but some can be quite expensive.

- Film cameras have been adapted to provide an immediate slide reproduction of a screen.

- Regular photography could be undertaken, if a high quality copy was desired and there was no hurry in obtaining a processed copy. Most users' requirements will be met by one of these alternatives, although the image printer was felt to be the most cost-effective route in the long-term.

4.7 Findings of the study

A number of the conclusions drawn from the various avenues which the study explored have already been indicated in sections 4.2, 4.3, and 4.6, and will not be repeated in the same detail here. Despite the delays, setbacks, and technical problems encountered, project participants were largely confirmed in their expectation that an interactive optical disc system could be put together to meet the requirements of envisaged museum applications.

As quality of image produced was one of the major factors to be investigated, the various discs produced during the pilot were demonstrated together, unlabelled as to their mode of production, for members of museum management to evaluate on a comparative and subjective basis. The clear consensus was that the Control Data system gave better results than the GEAC equipment, but that the Panasonic OMDR produced distinctly better quality images than either of the digital systems. This confirmed the findings of more objective, technical comparisons of the disc images. An analogue DRAW image ought to be able to provide the same quality as a video camera shooting a scene without motion. In fact the technology is not quite that good. Certain visual flaws may occur in the process, such as drop-outs (small lines that mark the screen), although these can be largely, if not entirely, eliminated by a built-in "drop-out compensator".

The Panasonic OMDR was found to have few drop-outs, and produced a very nice picture; the high resolution model whose input board had been modified locally gave even better results, which might be described as "broadcast quality".[30] Even without this improvement the product-image, on either of the models tested, was found perfectly acceptable for museum needs. Furthermore, the Panasonic system was found to be fast in placing images on disc and quite flexible regarding interface with a computer. Consequently the pilot project report recommended the Panasonic equipment structure [see Appendix I] for use in the museum. The Panasonic recorder was, in itself, more costly than a digital recorder - $24,500, plus $3,000 for the modification to the video input board - but the digital units required more hardware and programming overall to provide a complete operating system. And the playback unit was much lower in cost ($6,200), an advantage considering that many more playback than recording units would be needed by the museum; as the digital units were combined recording/playback units it would have been expensive to buy large numbers. The separate units in the Panasonic system also permit easy production of duplicate discs in-house, although some reduction in image quality might be expected as subsequent generations of copies are produced. In fact, however, the museum is not necessarily intending to use the DRAW system to produce duplicates. While DRAW is an excellent method for producing master discs, videodisc is a preferable format for replication and distribution, partly because it is cheaper to produce quantities, partly because the 12" videodiscs hold more than twice as many images as the 8" DRAW discs, and partly because videodisc players are far more commonly owned by consumers. Although master videodiscs are more expensive to record than optical discs, the playback units are cheaper and videodiscs have a standard format allowing them to be played on almost any videodisc player. Once the CAV project component is completed, it should be known whether the NFB route is necessary to produce images, on videodisc, of optimal quality; in which case pricing of the discs for sale would have to reflect the expense of this process.

CD-ROM will also be considered as the medium for copies made for exhibit support, as its smaller capacity should still be adequate for this application, and since decreasing costs of CD-ROM manufacture and hardware make it an attractive option. At the moment CD-ROM is primarily a textual medium, but one of the present "hot topics" in the field is the work being done on developing CD-I (Compact Disc-Interactive) which will better accommodate audio and video in addition to text. CMC's policy is not to commit itself irrevocably to any single branch of the technology, at the expense of ignoring new formats or entirely new technologies for information management.

Optical discs were found to accommodate images form a wide array of sources: slides, negatives, movie film, even x-ray images could be reproduced quite well; and these images could be transferred to disc with relative ease and at low cost. The only difficulty occurs in that photographic materials used as the source for recording are not necessarily produced for viewing on a TV monitor, so that reformatting work will be desirable. It has elsewhere been recommended[31] that colour negative film be preferred to slide film, whenever possible, as there is more flexibility with colour correction and with obtaining a desirable contrast ratio. Analogue discs do not, however, reproduce text very well, although it is probable that use of a very high resolution monitor would make even text legible. Because the weak link in the chain, as regards optical disc systems, is the resolution quality of monitors currently available at affordable prices, it is recommended that the highest quality image should be recorded, as im-

provements in monitor technology will allow true recording quality to shine through. Thus it may be suggested that recording the artifacts directly is preferable to recording surrogates (i.e. photographic images) of artifacts. This type of original production will also allow for better composition than would reproducing a photographic source.

Although the interactive element is not essential to optical information systems, to omit it is to fail to take full advantage of the benefits of automation, in terms of efficiency of information retrieval, and the increase in productivity that this can engender. Of course, this element adds to the cost of the system. Besides the cost of a microcomputer itself, there is the expense of a database management package (involving components such as system control modules, search modules, communications module, data dictionary, basic input screens) and the need for staff with at least a little familiarity with microcomputer operation. The best options for programming are to identify an off-the-shelf software package which closely approximates one's requirements and to customize it, or to acquire a general database management package and create a programme for a specific application. Experience from the pilot project indicated either route to be feasible for CMC. It would also be possible to write a series of programmes, one per application, that would be used with a single (master) disc, and would in essence "customize" that disc for each separate application. However, such programming would be expensive and any errors in the programme, or something as simple as interruption in the power-flow to the system while operating, would disrupt the whole sequence of frames to be shown.[32] The easier route is to produce, from the master disc, copies edited to serve specialized needs. At this point, exhibit design in CMC is not sufficiently advanced that such specialized discs can be produced for exhibit support.

The CMC is fortunate to have had the resources to be able to carry out a pilot project of this nature, and to be able to afford the recommended system and undertake optical recording operations. Optical storage technology is presently, however, still out of the range of numerous small museums functioning on a limited budgets. What this report would like to point out is that there are Canadian museums of less meager resources which may find optical information systems within their financial reach, and offering cost-saving benefits which repay the initial investment. It is in fact not so much the cost of the hardware and software that is so great, particularly considering that recording images on disc is substantially cheaper than recording an artifactual collection by traditional photographic methods and maintaining a photographic archive. Organizing the data (be it textual, photographic, or original artifacts) to go onto disc can be a more expensive element in the process.

Many museums, lacking in-house expertise, an audio-visual laboratory, or the ability to buy optical recording equipment, will find it cheaper to have the work done by outside agencies - this applies both to video recording and to preparation of the interactive programming - and there is some anticipation that the Museum Assistance Programmes component of the Department of Communication may receive applications for funding for such projects in the future. Much will also depend on other types of resources at a museum's disposal. A museum wishing to have a disc produced by a commercial organization will need source materials to provide that organization, such as a collection of photographic materials;[33] many museums lack even this. And those museums which are part of the CHIN network, or have an in-house machine-readable database of collections catalogue records again have a leg up in the creation of an interactive optical information system.

5.0 THE OPERATIONAL PHASE

5.1 Recording the collections

5.1.1 The CCFCS project:

At the beginning of the 1986/87 fiscal year CMC's Optical Disc Project passed to an implementation phase, encompassing the systematic video recording of the artifactual collections to produce the archival discs suitable for collections management purposes. As with the pilot project, CCFCS collections have been the focus of this effort, thus far. At just over 22,000 artifacts, CCFCS has the smallest of the Divisional collections - although it consumes about as much storage space as that of any other Division, while CCFCS also holds large non-artifactual collections - but it is the first to have been transferred in entirety, begun to be unpacked, and placed on storage shelving in the interim home for the Divisions: an effort at centralization to facilitate the move to the new museum beginning in 1989. With a single recording team operating, this was the only collection that could be completely recorded in time for the 1989 deadline for the new museum opening.

The goals for this phase of the operation are: to record on discs the total artifactual collection of CCFCS, coupling visual images to computerized textual records, in an interactive system; to create, from the archival discs, customized copies designed to support the four exhibition projects of that Division approved for the opening of the new museum; and to provide a framework of experience that will be of use to the other Divisions, when their turn comes to undertake recording operations. The work uses essentially the same equipment structure recommended by the pilot project report [Appendix I] - that is, the analogue DRAW Panasonic OMDR. And the same type of three- person operational team carries out the core work: the project leader, supervising and coordinating the various elements of the work; the video technician, who operates the television equipment, the testing units which allow control of picture quality, the OMDR, the interface to the IBM microcomputer, and the set lighting system; and the museum technician, who locates, retrieves, dusts, and replaces in its correct storage location each artifact designated for recording, and who deals with the CHIN data. The team is much assisted by CCFCS' Registrar, who instructs the museum technician on which artifacts to retrieve and supervises the handling of artifacts, arranges for the provision of CHIN data and organizes it into packages relating to the classes of artifacts selected for recording, coordinates the provision of artifacts and data in such a way as to ensure appropriate workflow, and identifies and prioritizes the class groupings of artifacts for recording purposes. In the last process staff curators and researchers also have input.

The collection has been divided into classes of artifacts, with each class being recorded, as a whole, in its turn. The order in which classes are recorded is determined, primarily, by the types of artifacts that have been most heavily tapped by exhibit design teams. It has also been necessary to arrange the classes so that there is adherence to the space limits of a disc; that is, so that a group is contained entirely within one disc, not overflowing onto a second. Each artifact contributes 5 separate images to a disc. The first (whose frame number ends either with -1 or -6) is an overall view of the artifact, while the other four are either views from different angles or close-up/detail shots. A minority of artifacts will require more detailed recording -

motor vehicles in the collection, for example - and may be assigned as many as 350 frames each. Recording of these artifacts has not yet commenced; they will be added at the end of the main class groupings on each disc. Each 8" disc has a 24,000 frame capacity; given 5 frames for most artifacts, each disc is expected to accommodate, initially, approximately 4,000 artifacts, depending on the actual size of each class and the combined totals of classes assigned to one disc. The remaining frames on a disc will accommodate: a) artifacts requiring more than 5 frames; b) a number of textual items relating to the interactive programming; c) the later addition of new accessions. Such new accessions will be integrated into the classes to which they belong when updates are made of discs (probably on an annual or biennial basis), at which times it will be considered whether major reallocations of classes are necessary because their growth has led to them overflowing a disc's capacity limits.

The projected time-frame for recording the CCFCS collection is roughly 1.5 years (300 working days), as one disc can be produced, it has been estimated, on average every 57 working days, and the whole collection can be held on 5 discs. These discs will not be suitable, as is, for exhibit support; the general public does not want to see five or more views of every artifact, nor a series of very similar artifacts in sequence - browsing these would prove tedious for most.

5.1.2 Progress of the project:

With the sequencing of classes of artifacts on the discs determined [see Appendix II], the actual work of recording began in August 1986, in a space adjacent to the collections storage area. The Musical Instruments class was dealt with first; average production in the first two weeks was only 18.5 artifacts a day, but this was to be expected during what was essentially a start-up and training period. No major problems were encountered, however, except that the original lighting equipment began to break down under a full day's use, and had to be replaced by heavy duty Colartran units. As the team moved on to the Ethnic Decorative artifacts, its production rate picked up; during the first 8 weeks 1991 artifacts were recorded (9,956 frames total), an average of 52.4 per day. The next group of artifacts - Easter Eggs - were even easier to deal with and the daily average reached a peak of 185. The rate was slowed somewhat when the quilts collection was dealt with; being large and difficult to handle, and tending to sag if fastened for vertical display (which would have provided a poor image as well as damaging the quilts), a new set-up for photography was necessary; the quilts were laid flat on a grey protective sheet (which also served as backdrop) on the floor, and the camera was repositioned to photograph the quilts from above, taking advantage of the mezzanine grill-flooring in the storage room. This aerial photography was found to serve well for most other textile/costume items too, as they were easier to display and to manipulate (e.g. open up) if laid flat. After 18 weeks of production, the team was working on the second disc; 6,538 artifacts has been recorded (32,690 frames), an average of 76 per day, or an adjusted average (ignoring the first two weeks) of 82.7. This put the team ahead of schedule, since a daily average of 70 had been expected, but the time gained will doubtless be lost again when large artifacts, difficult to handle and requiring more than 5 frames, are dealt with. An error rate of .29% (95 frames) was experienced in this period.

Very recently Panasonic put on the market a new recorder, the TQ-2026F (which is in fact both a recording and a playback unit), and an accompanying playback machine, the TQ-2027F. These have various features additional to the earlier models, such as the ability to

produce, without a computer, an automatic multi-page, multi-mode repeat playback programme capable of holding up to 35 commands, and the means to link machines in a series for continuous recording or playback beyond the limits of a single disc. It is symptomatic of the industry in general that, despite the improved capabilities of the new model, the price is significantly lower than that of its predecessor ($24,500 as opposed to $39,500; the price of discs has dropped from $390 to $257). The CMC has acquired the new models for the ethnology division.

5.1.3 Future plans:

Using only one recording team, it was estimated that to reduce the total museum collections to disc would take at least 8 years, handling each Division in turn. There is of course the danger that by the end of this period some new technology may have appeared which makes optical disc systems redundant! The desire to make more rapid progress, coupled with the successful example of the CCFCS project, has led to a decision by museum management to set up a second team which is now working on the ethnology collection. Approximately one third of the Ethnology collection has already been recorded. History is now online processing their collections and Archeology will follow in the Spring of 1988.

Other elements from the original pilot project which could not be completed are now underway again, or about to be continued: the CAV, the audio collection, and the exhibit design support sub-projects. A further interesting development is that a native group from Northern Canada, planning to undertake its own, self-funded, videodisc project, has approached the CMC for assistance. The CMC will design a system, provide a methodology, and supply a copy of the interactive programme being developed for its own system; in return for which the native group will give copies of the discs produced, holding images of some 200,000 Inuit drawings, to the museum. This is the type of cooperative project the CMC would like to encourage. Other international museums have expressed interest in using the interactive programme being developed for CMC.

5.2 The textual database and database management programme

A wide range of searching capabilities is available for optical information systems, from the simple, but limited, access route of stand-alone systems to sophisticated retrieval techniques made possible by a computer interface. It is tempting to try to provide state-of-the-art capabilities when designing a search programme for an interactive system. But there is a need to strike a balance between making search techniques too complex for novice users, most of whom may lack computer experience, and making them so simple that searchers' options are overly limited. Bearing in mind that a large percentage of museum visitors are not computer-literate, and that the computer experience of most staff members is also quite limited, the CMC interactive optical disc system will rely on a multi-level menu-based retrieval approach including touch screens.

The database management programme designed for the applications envisaged by CMC will have two basic functions: to allow users to access specific images or textual records in the system by entering a set of search parameters, and to allow users to call up when viewing an image the related textual record (or vice versa). CMC does not have the expertise to perform such programming in-house; therefore several commercial firms were contacted and queried regarding the provision of an interactive programme. The proposal by Fountain Technical Services was felt, by CHIN experts, to best meet the museum's requirements at a

reasonable cost, and they were therefore awarded the contract in November 1986.

The programme is being developed using dBase III, which means that CMC will have to make a licensing agreement with Ashton-Tate, the software producers, before it can market the discs with an interactive programme. Also part of the database management package will be a conversion utility to accept data from the CHIN database and convert it to the form necessary for the CMC system, and a video player driver, a short C programme which will send out commands and receive drive response codes, permit textual strings to be overlaid on the video image, and will keep track of which of the various CMC discs is in use in the player. Macro and data dictionary techniques will facilitate changing of the field structure of the tombstone records, if necessary.

In fact the structure of those records has undergone several changes during the evolution of the project. The records used during the pilot project had 11 fields, 9 of them based on existing catalogue record structure [34] and 2 (frame number, source of the image for recording purposes) specific to the project. This was expanded to 26 fields, 8 of them searchable, when plans were being made for the project's operational phase, and later several mnemonics for field-names were altered to bring them in line with CHIN's new Humanities Data Dictionary. A full list of these fields is given in Appendix III.

The operating procedure for Interactive Videodisc System, CCFCS includes:

- *System Hardware* - The VMAS (Videodisc Museum Artifact System), was designed under the specifications of CCFCS. The hardware has evolved into the present structure through stages, testing different types of computers and programs. The most recent unit, and that felt to quite well satisfy the Divisional requirements, is the IBM-model 60.

The microcomputer is connected to the Panasonic videodisc player, and directs that unit to display the images attached to the artifact records. The computer is also connected to a text printer that can produce a copy of what is seen on the terminal. The videodisc player is connected to an image printer that provides a low grade black and white print of the images seen on the video monitor.

The equipment structure is the most recent type of technology being used for interactive image management. Despite the fact that technology is in a constant state of change, this structure is projected to remain current for some years. The equipment standards being set are becoming accepted by other Museum and Archive facilities.

Other applications in our Museum will probably use a larger and faster microcomputer, such as the IBM model 80, because of the size of their collections, but the basic video-image production will remain constant for all projects.

- *Starting from ZERO* - Before the computer is turned on, all of the other hardware must be operational. The videodisc palyer is to contain disc A, and set on the first frame of the disc. That is done by pushing the power switch and then the EJECT button. The tray will open, and if the tray does not contain disc A, insert it now. Then push the EJECT button again, the drawer will close, wait a moment then push the step-forward button. This will place the player on frame one. The next button to

push is the ON-LINE button. This will connect the player to the computer. The player is now ready.

Check to assure that all other power switches are on except the computer. When all units are ready, turn on the computer power switch. The start-up program is designed to perform all the normal functions that will set the computer program in operation. The first screen to stop is that requesting the user to push the function key F8. Those function keys are on the top rown of the keyboard. Pushing F8 will develop the next screen which provides a choice to the user of the type of functional structure desired. For our purposes, at this stage, simply push F8 again, that will select the SEARCH function.

This SEARCH mode will produce a screen containing a list of pneumonics that are similar to those on the CHIN, PARIS system. The user can enter data in as many fields as needed, then push the F8 key again.

After the computer searches the records for those that meet your requirements, the user is requested to push F8 to see the list. A list of records is displayed that meet the search requirements. By pushing the F8 key again, the first record from that list will be displayed on the text terminal. At the same time the frame number of the image and commands the videodisc payer to show that image.

There are five images shot of each artifact, and they can be seen by pushing the F2 key. The next artifact can be seen by using the F4 key, the previous artifact on the list by using the F3 key. Stepping forward through the shots on an artifact is the function of the F2 key and reverse by using the F1 key. All of these commands are indicated at the bottom of the computer screen.

- *Other Image Discs* - There are five discs A to E used to record all of the artifacts in the Folklore collections. When running down a list of records found in a SEARCH, it may be necessary to view some of the artifacts found on another disc. This will be indicated by the computer sounding a beep, and the bottom line on the computer screen will indicate what disc to install on the player.

To change a disc as required by the computer, push the ON-LINE button, then the EJECT button of the player. Change the disc to the one indicated. Push the EJECT button again, then step the disc forward to the first frame. Now push the ON-LINE button to connect the computer. It is now necessary to simply push the ENTER key on the keyboard, and the computer will set everything back in motion.

- *Options* - The searching and access to both images and text is one function of the system, in fact the main function. Another option is to print an image of the artifact being viewed. To do this, with the image showing on the video screen, simply push the PRINT button on the Mitsubishi Image Printer. This will provide a black and white copy of the video screen.

In order to get printed copy of the computer text screen, simply push the SCREEN PRINT button on the keyboard. This will produce the page of text that is presetly being viewed. With both of these docu-

ments, one can be provided a complete record of that object.

To acquire further and more detailed information on any artifacts, it is necessary to contact the Curator of the Folklore collections, by appointment.

- *Shutdown* - After completing all the searches required, and in order to close down the system, the following is necessary. First, when the computer screen indicates an F9 at the bottom line, the user may push that key. The computer will then produce another screen where the user pushes F9 again. The screen will close providing a line, where the user types SHUTDOWN, then push the ENTER key. That complete, simply turn off all other power to the units. The first power button to turn off is the computer, the rest can be done in any order.

5.3 Overall system setup and search process

Some twenty to thirty discs will be required to hold images of the total artifactual collections of the CMC, a number which will expand further if supporting documentation is also put on this medium. It is anticipated that, once a set of master discs is prepared, the information will be transferred from the 8" DRAW discs to 12" videodiscs, which are more space-effective; even a single-sided 12" disc can hold twice as much as the 8" disc. The transfer process costs roughly $2,400 for each 12" disc. The interactive programme being designed for the CMC system will include command protocol structures for both types of disc, and one of the first menu screens to be presented to the user will allow him/her to specify which type of playback machine is being used: the Panasonic, or a videodisc player (Sony LDP-2000 is the model that has been adopted by the museum for this purpose). Videodisc will be the format for discs intended for public dissemination. The DRAW master discs will be used only for collections management purposes.

Various technological options exist for obtaining access to a database which is distributed amongst a number of storage containers (i.e. discs), but these are complicated by the need to cater to a multi-user environment. Jukeboxes have been designed to allow access to a multi-disc database; but these tend to be rather expensive pieces of equipment, and are normally only single-user devices. It is also possible to stack discs on a single player having multiple read heads, although only a small number of discs can be thus accommodated; some single-disc players also use multiple heads, to allow simultaneous access by separate users to different segments of the same disc. [35] The approach that the CMC plans to take is to rack-mount a quantity of single-disc players and link them to a controlling central computer. Multiple users will have access to this system via a Local Area Network, using multiplexing technology. A drawback to this system is that only one user can consult a particular disc at any one time. Although it seems unlikely that circumstances will often arise when more than one user will want access to the same disc (bearing in mind that collections management staff will have access to one set of discs - the DRAW discs - and users of the Médiathèque to the videodisc set), the possibility is being considered of combining the rack-mounted and multi-head player approaches.

The type of work-station used by staff or by clients of the Médiathèque would consist of: a laser disc player (be it Sony or Panasonic), with a colour video display; a microcomputer having 640k RAM and sufficient hard disk storage to hold all the textual data associated with the

disc or discs being accessed, with a monochrome monitor. Researchers will control the interactive system by a function-key-driven software interface. In fact, work-stations in public areas will employ a keyboard having only the function keys which, rather than the traditional keyboard keys that are susceptible to excessive use (hammering) or vandalism (prying loose), will be membrane- covered and pressure-sensitive. It is also being considered whether interactive systems used in the galleries for exhibit support will employ touch-screen technology.

A user of the system will first see a screen bearing the CMC logo and the system's title. One of the following screens will provide explanation of how to use the system; this help screen will be able to be called up by users at any stage in the operation of the programme.[36] The number of functions that a searcher may need to perform will be kept to a minimum, to avoid confusing and discouraging users with no experience of automated retrieval systems; the most complex operation involved will be to provide a string of instructions aimed at developing a hit-list of visual/textual records which should be able to provide information relevant to the user's particular information need. Another early help screen will inform users of the general contents of each disc, and from this the user will select which disc or discs he or she wishes to search; on the basis of the instructions at this stage, the database management programme will select the appropriate textual file(s) as well. Some searchers may cover large sections of, or indeed the entire, database and hit-lists will indicate on which disc each hit resides. The rapidity of searching will depend partly on how large a portion of the database is subject to the search, but it is hoped to restrict the upper limit to about 15 seconds.

A hit-list will be developed by presenting the searcher with a series of menus. A list of subject-headings under which records may be sought will be placed on a sequence of frames near the end of each disc. This list will contain terms, all nouns, from the searchable fields of the tombstone records. For searching purposes these subject-headings will be broken down into groups of ten and a multi-level hierarchical structure (from general to specific) will be created from these groups and reflected in a series of menus and sub- menus. Searchers will use the function keys to select from these groups of ten the parameter relevant to their topic of interest, and so will gradually narrow down the search. A search employing, say, three separately specified parameters, selected from the menus, will provide a hit-list in a matter of seconds. It is expected that three parameters should suffice, in many cases, to produce a hit-list of workable size, but if the list exceeds 50 hits the searcher will be given the opportunity to continue narrowing down the search, by adding further search parameters.

Once a satisfactory hit-list is developed, the searcher can retrieve the records on the list. Again using the function keys, the searcher will be able to scan the records retrieved to assess the pertinence of each to the user's enquiry. As the user steps through the records on the hit-list, both images and textual records will be brought, simultaneously, to the two display screens. An optional form of access will enable a searcher to browse the visual database, and when an image of interest is found the related textual record can be retrieved by pushing a function key. Or, alternatively, the searcher may browse the textual database, then call up the artifact image associated with any record of interest. Appendix IV shows a simplified flow-chart illustrating this type of operation. Most users will probably find it preferable - faster and easier - to scan images than texts. The image frame number will be the reference point linking the two types of record for this bi-directional call-up process.

6.0 IMAGE AUTOMATION AND MUSEUMS

Laser disc technology is beginning to have a significant impact on the information sector: on educational, cultural, governmental, or commercial institutions whose functions revolve around the handling and dissemination of information. Its impressive storage capacity, low cost (per item stored), ability to accommodate different types of media, compact size, potential for fast and random access to contents, and its durability and robustness, make it attractive for a wide range of applications. And indeed, as the examples of museums, libraries, and various other types of institution show, it has been used for a variety of purposes. But nowhere - except perhaps at EPCOT, designed as a showplace for new technology - does one encounter the impression that optical information systems have been used simply for the sake of the newness of the technology, because of its high profile or because it is a gimmick which will attract the public. Where it has been used this has been for reasons of operational effectiveness, and after the worth of the technology has been demonstrated by pilot tests aimed at evaluating systems prior to purchase.

This is certainly true of the Canadian Museum of Civilization Optical Disc Project. The committment of the federal government to building a new museum may have provided the fortunate opportunity for the CMC to re-evaluate its facilities, operations, and programmes, and to consider options for improvement. But the museum's decision to implement an optical information system was based upon such a system having been shown by, and to the satisfaction of, its own staff to possess the capabilities to meet identified museum objectives, and in a cost-effective manner.

Museums are natural markets for laser disc technology - especially analogue systems - because they are multi-media institutions and because of the importance of the visual experience in accessing the information sources of which they are guardians and interpreters. It would be naive to make some sweeping recommendation such as that all museums should invest in the technology. In an ideal world this might be true. In real life the technology is still beyond the financial grasp of many museums which have little flexibility in their budgets. But it is becoming more affordable, and this trend of dropping hardware prices may be expected to continue as the consumer market expands. It may already be within the reach of more museums than realize the fact. While the initial investment in an optical information system may be high, this must be balanced against a variety of benefits.

The types of benefits that the CMC anticipates have been indicated or implied at various points in this report, but the principal ones may be summarized here:

- Better access to collections information. That is, faster access, access to the separate Divisional collections from a single base, and access to visual and textual information together. Thus contributing to one of the principal objectives desired by the museum.

- Greater productivity. This is the outcome of the improved access to information and applies both to staff, whether involved in collections management or exhibit design, say, or to external re-

searchers. Less time need be spent searching for and acquiring information materials, and more time putting the information to good use. It should perhaps be stressed that optical storage technology is not perceived by the CMC as an automated system which will replace human workers, but one which will allow more effective use of human resources.

- Protection for the collections. Access to surrogate forms of information means that the actual artifacts will need to be used or handled less, thus contributing to their preservation. A comprehensive visual record of the collections also has ramifications for conservation and security operations.

- Less reliance on external services. The time and expense involved in acquiring hard-copy collections information from CHIN or NMC Photographic Services will be much reduced.

- Replacement of outdated equipment. Laser disc hardware offers a cheaper (both in terms of capital investment and maintenance costs) vehicle for providing audio-visual presentations in the public galleries and for maintenance of the Divisional audio collections.

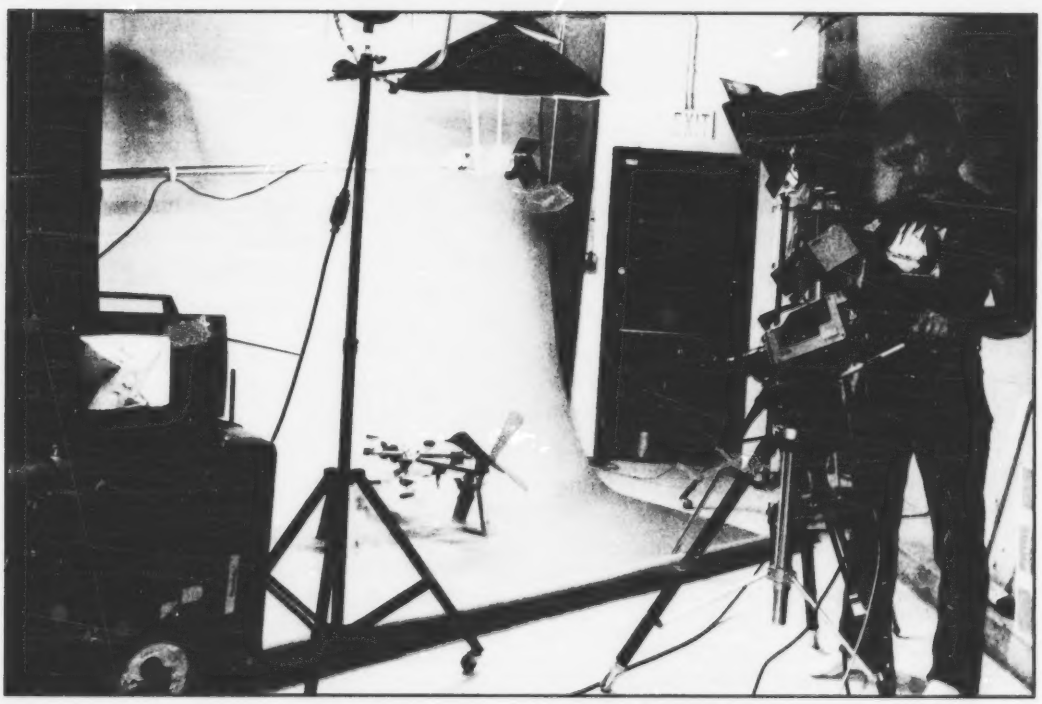
- Opportunity for improved programming. To use optical information systems for linear presentations is to under-exploit the technology. The interactive aspect of the technology offers the means to provide the self-paced, self-directed, participative interpretive/educational programming that is valued in museums.

- Information resource sharing. The suitability of the medium for mass replication and distribution offers the CMC an opportunity to provide greater access to collections information on a nationwide, or even international basis, as well as an opportunity to recoup some of the money invested in the technology.

We need perspective too. Laser disc images are not and can never be totally adequate substitutes for original artifacts, or for access to those originals. But there are some information needs which they can serve as well as the actual artifacts. And their ability to disperse that information to a wider audience than museums normally reach is an advantage not to be scorned. The fear has been expressed that disc-based images of artifacts could supplant the need for museums (except as institutions for collections management), or at the very least cause a decline in attendance, as collections are taken into private homes.[37] It seems highly unlikely that the typical visitor's fascination with original artifacts can be so easily undermined. Indeed, it is just as likely that distribution of artifact images will stimulate visits to see the "real thing". Nonetheless, there is a general trend in the information sector towards taking information to the user, rather than requiring the user to physically visit the institution where the information source is held. Another trend in modern information use is increasing appreciation of the value of pictorial materials. Museums will have to come to terms with their role in supplying both of these needs.

The beauty of optical information technology is perhaps that so many museum objectives can be achieved through a single system. What this report has tried to stress - and has at times perhaps belaboured the point - is that the benefits of using laser disc systems will repay

the financial investment that is required. The account herein of the CMC Optical Disc Project has not been intended to suggest some "master-plan" for the ideal system for a museum. There are a variety of types of laser disc, each having its own particular applications, and the CMC will itself be using more than one type to meet its needs. Insofar as the CMC pilot study reached any single, central conclusion, it is that, despite the hype surrounding digital disc systems, the more traditional analogue technology continues to offer a higher quality and more cost-effective tool for image management. What this report prefers to communicate, however, is the more general fact that there now exists a viable technology that can allow museums to provide a range and quality of services not previously possible. And above all to provide a workable solution to the long-standing dilemma of access versus preservation. Museums honestly interested in improving access to their information resources must be honestly interested in investigating how image automation can help them achieve this goal.



The 'artifact recording studio' adjacent to the collections holding area.

FOOTNOTES

1 Journals dedicated to the subject are Optical Information Systems (formerly Videodisc and Optical Disk), published by Meckler, and Optical Memory News, published by Rothchild; Library Hi Tech and Electronic Library also frequently contain articles on the subject. Recent monographs dealing with the subject include: Tony Hendley, Videodiscs, compact discs and digital optical disks, Hatfield (UK): Cimtech, 1985; Jordan Isailovic, Videodisc and optical memory systems, Englewood Cliffs (N.J.): Prentice-Hall, 1984; William Saffady, Optical disks 1985: a state of the art review, Westport (Conn.): Mekler, 1985.

2 Reflective discs, which have mirror-like finishes, must be turned over to read or write on the second side. This is not the case with transmissive discs; here it is only necessary to refocus the laser onto the lower layer of information-bearing material - such refocusing can be achieved with great precision. 3 Digital data can be stored on videodisc, but this is not usually the primary medium for such data. Compact disc is an increasingly common read-only and digital medium; although present CD technology is best suited for text or digitized audio, the development is underway of a multi-media format - usually referred to as CD-I (CD interactive) - capable of accommodating computer graphics, video, audio, and text together on a disc. This will not be ready before the end of the decade.

4 The laser heats a magnetic substrate layer to produce a field which is reversible.

5 Some question has been raised as to the quality of images near the centre and outer edge of these discs. See Margaret Stott and Bill McLennan, Report on the videodisc research project, UBC Museum of Anthropology, produced for the NMC Museum Assistance Programmes, 1985, p.14. We are grateful to Dr. Stott for providing us with a copy of this report.

6 Several problems are identified in Stott and McLennan, op. cit., pp.14-17. EPCOT Center has experienced excessive heat build-up and parts burning out, but estimates 5,000 hours mean-time between failures (Ken Christie, "Practical advice from a videodisc designer," Museum News, 63/6 (Aug. 1985), p.33), while the monitors used by the National Library of Canada tended to lose colour and vertical hold after several hours of continuous use (Sabine Sonnemann, "The National Library videodisc," Optical disk technology and the library, Ottawa, 1985, p.34).

7 We are not aware of any such survey that is up-to-date. Optical Information Systems includes an ongoing directory of projects. Lists, with brief description, of projects may also be found in several articles listed in the bibliography at the end of this report (Nyerges, pp.272-74; Cash, pp.22-31; Stott, passim).

8 The report on this project, to be found in the NL publication Canadian Network Papers, no.9 (May 1985),is one of the better project reports to have been published.

9 Joan Cash, "Spinning towards the future: the museum on laser videodisc," Museum News, 63/6 (Aug. 1985), p.19.

10 For a selective list of discs created by or for museums and available for public pur-

chase, see Museum News, 63/6 (Aug. 1985), pp.34-35. 11 This project has experienced the frustration of inadequate funds to allow it to progress from the master-copy on film to the pressing of a master-disc.

12 The other being the Royal Ontario Museum. PARIS now serves all the National Museums, as well as a number of other museums across Canada, as a collections information-sharing network.

13 On the other hand, CHIN is investigating CD-ROM as a medium for distributing its textual database.

14 To have negatives made (from Photographic Services prints) for 20,000 artifacts would cost $13,750, on top of which there would have to be payment for duplicate prints for the daily work activities of staff.

15 The Canadian Ethnology Service also has a sizable audio collection.

16 If all these teams approached CHIN and Photographic Services at once for collections information, the system would be overloaded - and the cost of this information would be substantial.

17 Dennis Sinnett and Sheila Edwards, "Authoring systems: the key to widespread use of interactive videodisc technology," Library Hi Tech, 2/4 (1984), p.40.

18 Imagine, for example, the expense of producing, and distributing copies of, a book with many pages of text and numerous colour illustrations; or the cost of transmitting the amount of data a laser disc can hold via telecommunications channels!

19 In order to provide CMC staff with experience which might be capitalized on in the future.

20 It was necessary to discover if, or how well, laser discs could accommodate information whose source was diverse original formats and media.

21 16 person-days were estimated as being necessary to support the linking to PARIS.

22 This is a relatively cheap process to create a disc which provides the same data that would appear on the final master disc, except that the check disc's chemical structure breaks down after about six months. The reason for producing a check disc is to identify and correct any errors before the master disc is created.

23 As it was expected that this route would provide a lower quality image - the question really being whether such an image was nonetheless satisfactory - no plans were made to proceed on to making a separate final master disc.

24 The film, of weather-vanes, was shot at 30 frames per second, to permit the final videodisc to be stopped on any frame and provide a solid image. If shot at the standard 24 frames per second, the "still" image on the videodisc would in fact jitter.

25 Image resolution is determined primarily by the number of binary digits needed to capture each line of the video scan. Each set of digits controlling one spot on the screen is called a pixel; the larger the number of pixels (which are the smallest "picture element") the sharper an image will be defined. A screen of 300 pixels high by 300 pixels wide would not provide high resolution - the image would appear like the painting of the original. The larger the number of pixels, the higher the resolution. Upwards of 4,000 pixels across one scan line is possible, and in total more than 2 million pixels per screen could fit into one picture (computer images use an average of 300,000 pixels).

26 In an RGB system the video signal is converted to the primary colour components, and these red, green, and blue elements of the signal can then be treated independently. This is not the standard North American television signal, which is a composite video signal.

27 The OMDR will also accept direct signals from a VCR or video tuner.

28 The reason for increased capacity was a change from concentric-tracks format discs, to spiral track discs.

29 Small Computer System Interface, sometimes known as SASI (Shugart Associates System Interface) because based on that hardware. SCSI is a general-purpose intelligent controller which allows data to be distributed to peripherals such as hard drives and optical disc drives. The SCSI is also involved in functions such as data buffering, error correction, media flaw management, and self-diagnostics, during DRAW recording operations.

30 A drawback with the modification is that, to produce the enhanced image, a piece of equipment known as a Time Base Corrector must be used with the system.

31 Stott and McLennan, op. cit., p.21.

32 The reason being that the programmes operate by telling the system the number of frames to jump to reach the next desired frame. If a jump, for whatever reason, was even one frame out, so too would be the rest of the images shown.

33 Pre-mastering existing images for videodisc production costs roughly one to two dollars per image.

34 These were: title (i.e. type of artifact), maker, location, period, culture, material of composition, dimensions, catalogue number, and negative number (from the Photographic Services collection).

35 4 is the maximum number on North American systems, unless the user makes in-house modifications which would void the manufacturer's warrantee. Some Japanese systems have 8 heads.

36 A hard-copy manual of operations will also be made available for those who need it.

37 See, for example, E.M. Avedon's (slightly tongue-in-cheek) "Things to come?" Museum Quarterly, 15/2 (June 1986), 32.

SELECT BIBLIOGRAPHY

Avedon, E.M. "Things to come?" Museum Quarterly, 15/2 (June 1986), 28-32.

Bardes, D'Ellen. "Attention novices: friendly intro to shiny disks." Library Software Review, 5/4 (July/August 1986), 240-45.

Barker, Philip. "Video discs in libraries." The Electronic Library, 4/3 (June 1986), 166-76.

Cash, Joan. "Spinning toward the future: the museum on laser videodisc." Museum News, 63/6 (August 1985), 19-31.

Chen, Peter Pin-Shan. "The compact disk ROM: how it works." IEEE Spectrum, 23/4 (April 1986), 44-49.

Christie, Ken. "Practical advice from a videodisc designer." Museum News, 63/6 (August 1985), 31-34.

Connolly, James. "Kodak unveils optical disk subsystem, erasable demo." Computerworld, 17 November 1986.

"Domesday approaches." Outlook on Research Libraries, 7/4 (April 1985), 6.

Donahoe, Stephen. "Update on optical disk systems: assessing the technology." Records Management Bulletin, 2/1 (April-June 1986), 4-5.

Donahoe, Stephen. "Status of the optical disk in the Canadian federal government." Records Management Bulletin, 22 (July-September 1986), 1, 4-6.

"Douglas Cardinal's design for the Canadian National Museum of Man." International Journal of Museum Management and Curatorship, 4/1 (March 1985), 97-100.

Duchesne, Roddy. "The technology an its applications." Pages 8-16 in Optica' isk technology and the library, Canadian Network Papers, no.9 (April 1985).

Femenias, Blenda and Patricia K. Mansfield. "ARTSearch: an interactive videodisc computer system for museum collections." Museum Studies Journal, 2/1 (fall 1985), 50-58.

Herther, Nancy K. "CD ROM technology: a new era for information storage and retrieval?" Online, 9 (November 1985), 17-27.

Hessler, David W. "Interactive optical disc systems: part 1: analog storage." Library Hi Tech, 2/4 (1984), 25-32.

Kula, Sam. "Optical memories: archival storage system of the future, or more pie in the sky?" Archivaria, 4 (1977), 43-48.

Lynch, Clifford A. "Optical storage media, standards and technology life-cycle management." Records Management Quarterly, 20/1 (January 1986), 44-54.

Meadows, A.J., M. Gordon and A. Singleton. Dictionary of new information technology. London: Century, 1982.

Newman, Thomas. "Video discs: the emerging picture." Museum News, 59/4 (January/February 1981), 28-33.

Nugent, William R. and Jessica R. Harding. "Pictures and productivity: how image automation will amplify the output of the knowledge worker." Pages 36-40 in Proceedings of the 46th ASIS Annual Meeting. White Plains, N.Y.: Knowledge Industry Publications, 1983.

Nugent, William R. and Jessica R. Harding. "Advances in videodisc technology for

public access to collections of graphic materials." Pages 225-36 in Crossroads: proceedings of the First National Conference of the Library and Information Technology Association, September 17-21, 1983, Baltimore, Maryland. Chicago: American Library Association, 1984.

Nyerges, Alexander Lee. "Museums and the videodisc revolution: cautious involvement." Videodisc/Videotex, 2/4 (fall 1982), 267-74.

O'Connor, Mary Ann. "CD-ROM versus erasable compact disc." Videodisc and Optical Disk, 5/6 (November-December 1985), 464-67.

"Optical disks and information retrieval for libraries." Online Libraries and Microcomputers, 2/11 (November 1984), 1-3.

Oren, Tim and Gary A. Kildall. "The compact disk ROM: applications software." IEEE Spectrum, 23/4 (April 1986), 49-54.

Parker, Elisabeth Betz. "The Library of Congress non-print Optical Disk Pilot Program." Information Technology and Libraries, 4/4 (December 1985), 289-

Schaefer, Mary Tonne. "New hardware, software debut in CD-ROM technologies geared for libraries and information centers." Information Retrieval and Library Automation, 21/11 (April 1986), 1-5.

Schwerin, Julie B. "Optical systems for information delivery and storage." Electronic Publishing Review, 5/3 (1985), 193-98.

Sinnett, Dennis and Sheila Edwards. "Authoring systems: the key to widespread use of interactive videodisc technology." Library Hi Tech, 2/4 (1984), 39-50.

Smith, George W. "A new information retrieval system: Got a question? Just touch the screen!" Bell Laboratories Record, October 1982, 207-13.

Sonnemann, Sabine S. "The videodisc as a library tool." Special Libraries, 74/1 (January 1983), 7-13.

Sonnemann, Sabine S. "The National Library Videodisc Demonstration Project." Pages 17-35 in Optical disk technology and the library, Canadian Network Papers, no.9 (April 1985).

"Spreading culture via videodisc." Quill & Quire, 49/10 (October 1983).

Stott, Margaret A. "Videodisc: museums and the future." Muse, 3/4 (winter 1986), 44-46.

Stott, Margaret A. and Bill McLennan. Report on the videodisc research project, UBC Museum of Anthropology. Unpublished paper produced for Museum Assistance Programmes, National Museums of Canada, 1985.

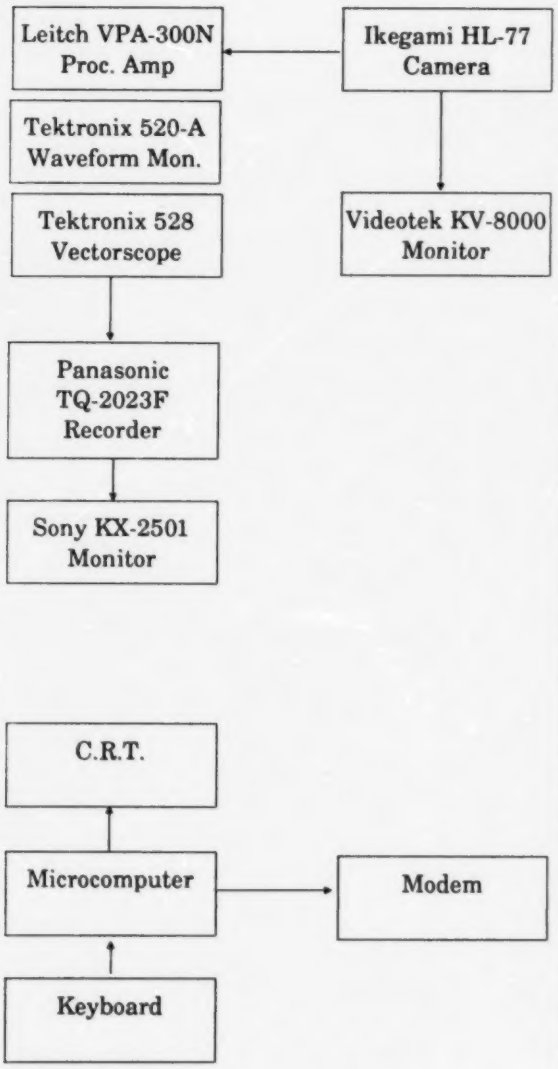
"The use of the Panasonic Optical Memory Disc Recorder (OMDR) system in Canada." Videodisc Monitor, January 1987, 13, 15.

Vries, E.A. de. "Museum information by means of computer and videodisc for public use." Electronic Publishing Review, 6/3 (1986), 145-49.

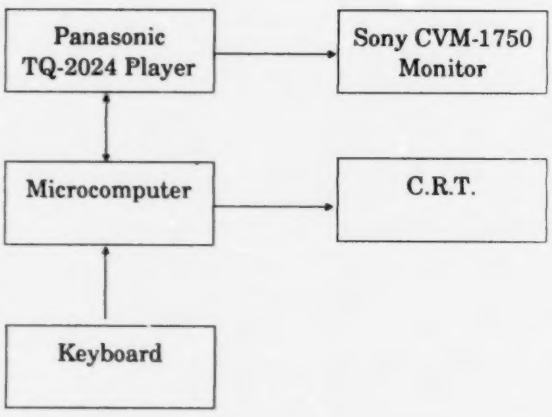
Waurzyniak, Patrick. "Optical disks." InfoWorld, 8/49 (8 December 1986), 51- 55.

APPENDIX I

RECORDING EQUIPMENT STRUCTURE



PLAYBACK EQUIPMENT



APPENDIX II

CONTENTS OF THE CCFCS OPTICAL DISCS

class of artifact — *no. of artifacts*

Disc "A"

1) Musical Instruments 500
   a) Membranophones
   b) Idiophones
   c) Aerophones
   d) Chordophones
2) Ethnic Decorative 2100
3) Easter Eggs 1550

TOTAL 4150

Disc "B"

1) Textiles 3000
   a) Bed coverings
   b) Floor coverings
   c) Miscellaneous (towels, doillies, etc.)
   d) Costumes and accessories
2) Contemporary Crafts 1110

TOTAL 4110

Disc "C"

1) Folk Art 2340
   a) Human
   b) Models
   c) Religious
   d) Relief carvings
   e) Paintings
   f) Animal

2) Weathervanes and Whirligigs 170

3) Birdhouses 100

4) Garden Art 200

5) Decoys 550

6) Utilitarian Decorative 495

a) Sugar moulds

b) Butter moulds and stamps

c) Canes

d) Trade signs

e) Wall shelves and cabinets

7) Chests and Boxes 200

Total 4055

Disc "D"

1) Furnishings 395

a) Cabinets, cupboards, etc.

b) Beds

c) Cradles

d) Tables

e) Benches

f) Chairs

2) Folk Medicine 700

3) Decorative Implements 1975

Total 3075

Disc "E"

1) Tools and Implements 3265

2) Large Items 15

3) Miscellaneous ..... ?

Total 3280

APPENDIX III

Structure of the tombstone records

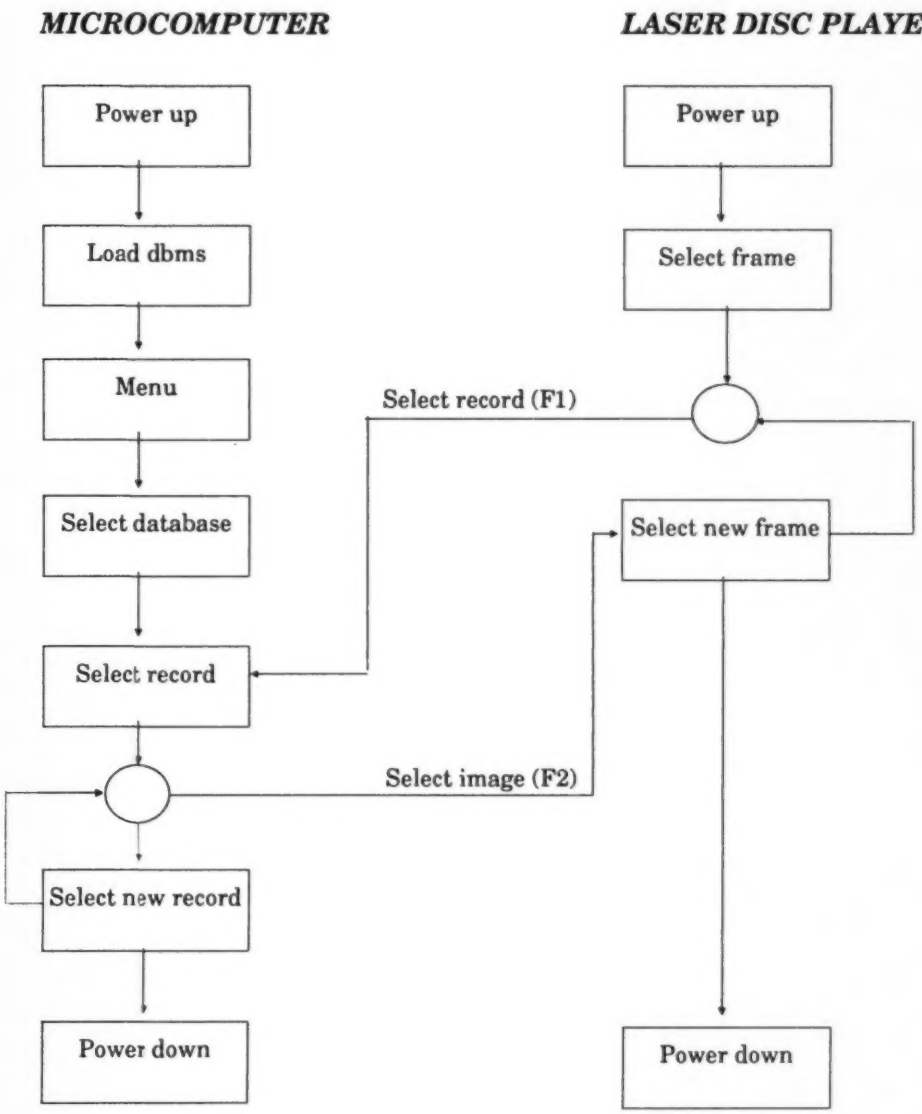
(derived from CHIN database, and subsequently modified)

Field Mnemonic	Maximum Field	Length Description
PAR	10	PARIS number
* OB	30	Object name
* OT	35	Object type
PAT	30	Pattern
* AMM	65	Maker or manufacturer
* CM	15	Country of manufacture
PTM	15	Province or territory of manufacture
DCM	15	District or county of manufacture
LM	25	Locality of manufacture
GAR	25	Geographic area
PDF	8	Period from:
PDT	8	Period to:
* CUL	20	Culture
* RG	30	Religious affiliation
MA	30	Material
PNN	15	Photo negative number
* CAN	13	Catalogue number
UNL	4	Unit of linear measurement
* FN	6	Frame number
F	2	Number of images per object
GM	30	General Measurement
LE	8	Length
WI	8	Width
HT	8	Height
DP	8	Depth
TH	8	Thickness

The two fields, F and FN, did not derive from the CHIN database, PARIS; FN (which has since been incorporated into PARIS) will be used to access the appropriate optical disc frame. The UNL field is an amalgamation of physical measurements (length, width, height, depth, thickness, diameter) each of which will be distinguished from the others by single-character separators.

An asterisk (*) indicates the fields which will be searchable by the interactive programme.

APPENIDIX IV



FLOW CHART SHOWING SIMPLIFIED PROGRAMME OPERATION

"The new museum should aim, it was decided, at providing the general public, scholars, educators, young people, and clients with special needs and interests with access to the collections, and to the knowledge which makes them meaningful, to the fullest degree possible and by a variety of means."

By December 1987, the Canadian Museum of Civilization (CMC) completed the pilot phase of the optical disc project; it has already entered the operational phase of recording images of every artifact in its collection on the interactive laser-read optical disc system. The system integrates computer-retrieved textual information on pictorial and artifactual collections, with images of those collections on a second screen. Printers can also be linked to the system, producing either coloured prints of publishable quality, or fast and inexpensive black-and-white prints, suitable for many purposes.

Implementation of the optical disc system is helping to fulfill the CMC's goal of making its collections better known to the public in its new building, part of which is scheduled to open July 1989.

As the optical disc system becomes more thoroughly tested and better known, and as costs come down, it is expected that more museums and galleries will use it thus creating a wider and more accessible network of information on Canada's material culture.

National Museums of Canada Musées nationaux du Canada

Canada